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Research
Education
Information
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Control
Monitoring

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**PROGRESS
REPORT
ON
PESTICIDES
AND RELATED
ACTIVITIES**

U.S. DEPARTMENT OF AGRICULTURE AND COOPERATORS

FEBRUARY 1967⁵⁰ //

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1966 PROGRESS REPORT

ON

PESTICIDES

AND

RELATED ACTIVITIES //

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U.S. Department of Agriculture
and Cooperators //

U. S. DEPT. OF AGRICULTURE
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This report has been prepared in limited numbers. Persons having a special interest in the development of public pesticide and related programs may request copies from the Research Program Development and Evaluation Staff, Room 3119 South Building, USDA, Washington, D.C. 20250.

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Summary and Highlights

The pesticide and pesticide-related activities of the Department of Agriculture continue to be directed toward the development and use of safer, more specific and more effective pest control measures. These activities involve Research, Education, Information, Regulation, Pest Control, and Monitoring.

As shown on page 9, eleven USDA Services and Agencies are participating in a coordinated program. Within some Services a number of Divisions are engaged in several aspects of the program. The program is described under nine general targets. The nationwide effort is supplemented by programs in several foreign countries.

Examples of progress are:

1. New sources of germ plasm have been made available for breeding of pest-resistant crops.
2. The metabolism of several insects of economic importance has been further investigated. Weak links in life cycles have been found.
3. Animal parasites have been cultured outside of the host animal.
4. Route of transmission of animal disease by arthropod vectors has been established.
5. Witchweed stimulants have been extracted and identified.
6. Studies of plant diseases have provided additional information on susceptibility, mode of infection, method of transmission, nature of resistance and means of control.
7. The sex attractant of the pink bollworm, cabbage looper and the Ips bark beetle have been synthesized.
8. Artificial diets have been perfected which permit the rearing of insects both for laboratory study and for mass-rearing.

9. Parasites and predators have been mass-reared and released for the control of insects.
10. Eighteen spring varieties of wheat have shown resistance to both the larvae and adult forms of the cereal leaf beetle.
11. Effective management practices have been developed for weeds on grazing lands.
12. Disease resistant varieties of alfalfa, cotton, dry beans, grapes, strawberries, tobacco and tomatoes have been released.
13. Hot water dips can replace post harvest chemical treatments for control of storage decay.
14. A nonresidue fumigant is available for packaged goods and cereals in storage or transit.
15. New and safer mothproofing is available.
16. Improved pesticide application techniques now permit greater accuracy, better metering and saving of time.
17. Newly developed system provides reuse of spray material that does not hit target plant.
18. The presence of tolerance levels of ten classes of pesticides in eleven groups of foodstuffs can be determined on a routine basis.
19. The principle of low-volume application has been incorporated into ground application equipment.
20. A promising replacement has been found for the chlorinated hydrocarbon insecticides in forest insect control.
21. The movement and persistence of pesticides in soil can now be predicted by laboratory evaluation techniques.
22. A more complete understanding of the mechanism of action of herbicides has been attained.
23. When forested areas were aerial sprayed with DDT, no significant amounts of DDT were found in the streamwater.
24. Small biopsy samples taken from beef animals contained amounts of pesticides representative of the whole animal.
25. The rate of pesticide deposition in the fatty tissue of animals is influenced by other pesticides or drugs.

26. Ninety-four percent of the farmers used pesticides, to some extent, during 1964.
27. During 1964 an estimated \$480 million was spent by farmers for pesticides--85% spent for control of crop pests.
28. Aerial spraying of brushland returns an average of 25% of the investment annually.
29. During 1964 the total acreage treated for insect and disease control was 39.3 million and 64.5 million acres were treated for weed control.
30. During 1965 farmers spent an estimated \$590 million for pest control.
31. Basic data on pesticide supply and demand is kept current.
32. Round-the-clock quarantine programs intercepted 23,849 pests.
33. The Mediterranean fruit fly was promptly eradicated late in F.Y. 1966.
34. The cooperative national insect detection network reported eight new species during F.Y. 1966.
35. The Formosan termite was found in Texas and Louisiana.
36. Large area control and monitoring programs were conducted against witchweed, grasshopper, cereal leaf beetle and boll weevil.
37. Soil monitoring programs were started in areas of high, medium and no recorded usage of pesticides.
38. Domestic and imported meats were monitored for pesticide residues.
39. The number of new pesticide products registered increased by 32 percent.
40. A 17 percent increase was achieved in the number of approved labels.
41. Product surveillance was conducted on 3,500 samples.
42. Procedures were established for reregistration of products formerly registered on a "no residue" or a "zero tolerance" basis.
43. Pesticide safety spot announcements were furnished to 550 commercial television stations.

44. Cartoons offering tips on safe use of pesticides to the general public were distributed to 750 newspapers.
45. A 24-page illustrated booklet on our struggle against pests was distributed for use in schools and other youth groups.
46. The 1966 Yearbook of Agriculture titled "Protecting Our Food" was published and favorably received.
47. Informational materials suitable for classroom use was sent to 26,000 science teachers through cooperation with the National Science Teachers Association.
48. Arrangements have been made for the Pesticides Information Center to be converted to a computer-based system during F.Y. 1966.
49. The Pesticide Documentation Bulletin indexes 35,000 documents per year.
50. The Departmental Pesticide Committee consolidated all previous committees and provides Departmental coordination and guidance.
51. A national symposium on pest control was sponsored by contract with the National Academy of Sciences.
52. A symposium of aerial application of pesticides was sponsored.
53. Thirty-nine States have enacted an act developed by the Council of State Governments. A model law developed by the Department was used in drafting the act.
54. USDA research leaders participated in the pesticide programs of the United States-Japan Cooperative Science Program, FAO, WHO, Codex Alimentarius and the Organization for Economic Cooperation and Development.

C O N T E N T S

Summary and Highlights

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D E S C R I P T I O N O F P R O G R A M

The Department of Agriculture conducts, and otherwise supports, a comprehensive, forward looking in-depth program involving (1) pesticides and (2) related activities, the result or objective of which is pest control without using toxic chemicals or with only limited amounts of them. This report documents the general nature and objectives of this program and cites examples of specific activities and progress.

Pesticides are defined as economic poisons including (1) any substance or mixture of substances intended for preventing, destroying, repelling or mitigating any insects, rodents, nematodes, fungi, weeds, and other forms of plant or animal life or viruses, except viruses on or in living man or animals, which the Secretary of Agriculture shall declare to be a pest, and (2) any substance or mixture of substances intended for use as a plant regulator, defoliant or dessicant.

Related activities involve such things as: (1) developing crop varieties and trees that are resistant to attack by specific insects or diseases, (2) controlling certain economic pests by identifying, propagating and distributing predators or parasites specifically attacking those pests, (3) introducing pests with modified biological characteristics into natural populations in order to reduce or eliminate the pest by disrupting reproduction and (4) preventing the introduction of dangerous foreign pests.

Frequently the control of a pest involves both pesticidal and nonpesticidal methods. This "integrated control" approach is an inherent part of much of the work described in this report.

The program of the Department of Agriculture is firmly based on research. Knowledge gained through research is applied in education, information, regulation, pest control and monitoring activities. The pesticide and pesticide-related efforts of the Department are presented, in this report, under nine general targets shown on page 2. Examples of the kinds of work under each of the Targets are shown on pages 3 to 6.

A. Pesticide and Related Activities -- Targets of USDA Program

- I. To gain knowledge of the taxonomy, biology, ecology, physiology, pathology, metabolism, and nutrition of pests and host plants and animals.
- II. To improve and develop means of controlling pests by nonpesticidal methods.
- III. To develop safer and more effective pesticide use patterns, formulations, and methods of application; and improved methods for detecting, measuring and eliminating or minimizing pesticide residues in plants, animals and their products, and in the environment.
- IV. To study the toxicity, pathology and metabolism of pesticides and investigate levels, effect, and fate of their residues in plants, animals and their products, and in the environment.
- V. To study economic aspects of pest control; survey pesticide use; determine the supply and requirements for pesticides; and give assistance to control agencies and industry in emergencies.
- VI. To control pests.
- VII. To monitor the presence and distribution of pesticides in plants, animals, and their products, and in the environment.
- VIII. To administer the regulatory statute--the Federal Insecticide, Fungicide and Rodenticide Act--to assure properly labeled pesticides, with guidelines for their safe and effective use, and to prevent the marketing of harmful, adulterated or mis-branded products.
- IX. To educate and inform the public about the importance of pesticides and pest control, and the need for safe and proper use of pesticides; maintain a Pesticides Information Center; coordinate and review pesticide and pesticide-related activities of the U.S. Department of Agriculture and coordinate them with other Federal, State and private organizations.

B. Examples of Kinds of Work Encompassed by Targets

Target I - Fundamental biology. Studies of the taxonomy, biology, ecology, physiology, pathology, metabolism and nutrition of pests and hostplants and animals.

Includes research for:

1. Maintaining standards of reference for pests and host plants.
2. Propagating parasites outside of host animals and detailed study of the parasites.
3. Identifying and purifying naturally occurring weed seed stimulants.
4. Recovering plant virus from plants grown from true seed and transmitting the virus.
5. Extracting, purifying and identifying insect sex attractants.
6. Establishing physiological races of certain root rots of forest trees.

Target II - Improved means of nonpesticidal control. Control of pests by nonpesticidal means is an ultimate goal. Progress is being made through pest-resistant crops, pest attractants and repellants, release of predators, parasites and pathogens for specific pests and physical, cultural and mechanical control practices.

Includes research for:

1. Utilizing germ plasm collections for selective breeding.
2. Developing of resistant crops.
3. Extracting naturally occurring sex lures for mosquito, stored product insects and bark beetles.
4. Mulching with reflective material for repelling insects.
5. Controlling weeds by insects, snails and fish.
6. Controlling of insects of animals and crops with parasites.
7. Controlling of disease by vaccination.
8. Controlling insects by combined light traps and sex attractants.
9. Controlling insects by sterile male releases.
10. Reducing decay by hot water dipping.

Target III - Improved pesticide use patterns. Limitations of present and potential pesticides are studied to develop safer and more effective use patterns, better formulations, and more efficient application methods. Procedures are developed for detecting and measuring the pesticides and metabolites and for the elimination or minimizing residues.

Includes research for:

1. Fumigating stored products, both in storage and in transit, with nonresidual pesticides.
2. Mothproofing of woolens with newer nontoxic compounds.
3. Increasing the accuracy of aerial application of pesticides.
4. Evaluation of damage of insecticides and herbicides to crops.
5. Achieving insect control during drying of raisins by using treated drying trays.
6. Finding of promising replacements for persistent pesticides used in forest spraying.

Target IV - Toxicology, pathology, metabolism and fate of pesticides. Determination of the toxicological and pathological effects of pesticides and their metabolites, applied or fed to laboratory and farm animals, or applied to crops. Investigations of the levels of residue and their metabolic pathways in plants, animals and their products and in the environment.

Includes research for:

1. Screening of herbicidal compounds for gross toxicology and pathology in chickens, sheep and cattle.
2. Detoxifying herbicides used for weed control in corn.
3. Determining the metabolism of herbicides in rice.
4. Measuring the long-term persistence of pesticides in soils.
5. Evaluating the impact of forest pest control on the environment.
6. Determining the storage of residues in animal tissues.

Target V - Economies of pest control, use, supply, and requirements of pesticides. Determination of the economies of pest control, of where and what pesticides are used and studies of the supply and demand of pesticides.

Includes research for:

1. Determining the economic impact of grassland restoration by means of brush control.

2. Estimating nationwide use of pesticides.
3. Ascertaining the demand for pesticides, both nationally and internationally.

Target VI - Control of pests. Under certain conditions it is necessary that local, State or Federal agencies engage in area pest control programs. For example, such serious economic pests as grasshoppers, cereal leaf beetle, khapra beetle, spruce budworm, witchweed and certain aquatic weeds require large scale control efforts. In addition, it is vital that dangerous foreign pests be excluded from this country.

Includes action for:

1. Eradicating Mediterranean fruitfly.
2. Detecting and treating infestations promptly to prevent the spread of destructive insects.
3. Minimizing the threat of Western spread of boll weevil.
4. Intercepting thousands of pests at point of entry.
5. Discovering eight pest species new to the United States.

Target VII - Monitoring. The presence and distribution of pesticides is being measured through monitoring. In addition to a network of soil sampling locations, special-use area studies are conducted. Meat and poultry are systematically sampled and analyzed.

Includes actions for monitoring:

1. Large area boll weevil control program.
2. Soil in selected areas of high, moderate and no pesticide usage.
3. Domestic and imported meats.

Target VIII - Regulation. The Department of Agriculture is responsible, by law, for the Federal Insecticide, Fungicide and Rodenticide Act. Compliance with this Act assures properly labeled pesticides with guidelines for their safe and effective use.

Includes actions for:

1. Registering an increasing number of products.
2. Surveying products for compliance.

3. Participating in the development of interdepartmental procedures for registration.
4. Reevaluating registrations on basis of current information.

Target IX - Information, education and coordination. The results of research and facts about control efforts are transmitted through information and education activities. Constant emphasis is placed on safe and effective use of pesticides. A review of the voluminous literature on pesticides is regularly published. Departmental programs are coordinated with other Federal, State and private organizations.

Includes actions for:

1. Producing and distributing television and radio spot announcements on using pesticides safely.
2. Developing motion pictures on need for pesticides and their safe use.
3. Developing a computer-based information retrieval system.
4. Distributing educational materials to schools on a nationwide basis.
5. Conducting training meetings and schools on pesticide usage.
6. Participating in intra- and interdepartmental coordination.
7. Providing and distributing information on a nationwide basis for farmers and home owners on use of pesticides.

Numerous components of the Department of Agriculture are engaged in pesticides and related activities. These are shown on page 9, together with indications of the general types of activities with which they are involved. Many USDA employees are directly engaged in these activities. This is referred to as intramural work and is coded at the end of subsequent paragraphs describing activities and progress by "(I)." The Department also supports work done by other public and private agencies through such mechanics as contracts and grants. Major grant funds are expended to State Agricultural Experiment Stations and Schools of Forestry through procedures authorized by the Hatch and McIntire-Stennis Acts. This extramural work is coded by "(E)." There are numerous instances of a dual approach to getting a job done, i.e., "(I) and (E)."

The allocation of funds for fiscal years 1966 and 1967 and estimates for 1968 are shown on pages 11 through 19.

The Department of Agriculture was one of the sponsors of the Federal Committee on Pest Control. It participates actively in its work, including extensive membership within its several subcommittees. In addition, USDA scientists share in leadership and other membership participation in an Interdepartmental Weed Committee. The Department supported the establishment of Pesticide Coordinating Committees in each State. USDA employees regularly consult with these groups about policy and program matters as requested.

Close informal relationships are maintained with such industry and public organizations as the National Agricultural Chemicals Association, Manufacturing Chemists Association, Chemical Specialties Manufacturing Association, National Cannery Association, National Pest Control Association, Wildlife Management Institute and the National Safety Council. These contacts include frequent exchange of information and distributional materials.

Department leaders in pesticides and related activities are working with the Food and Agriculture and the World Health Organizations of the United Nations. They also participate in the pesticide activities of the Organization for Economic and Cooperative Development, the United States-Japanese Cooperative Program sponsored by the National Science Foundation and the Codex Alimentarius Commission, which establishes international Standards for food products.

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C. Participating USDA Services and Agencies

Organizational Unit	Activity					
	Research	Education	Information	Regulation	Control	Monitoring
Agricultural Research Service						
Division:						
Agricultural Engineering Research	X					
Animal Disease and Parasite Research	X					
Animal Husbandry Research	X					
Animal Health					X	
Crops Research	X					
Entomology Research	X					
Human Nutrition Research	X					
Information			X			
Market Quality Research	X					
Pesticides Regulation				X		
Plant Pest Control					X	X
Plant Quarantine					X	
Soil and Water Conservation Research	X					
Agricultural Stabilization and Conservation Service	X					
Cooperative State Research Service	X					
Forest Service						
Division:						
Forest Pest Control					X	
Forest Protection Research	X					
Information and Education		X	X			
Timber Management Research	X					
Watershed, Recreation & Range Research	X					
Federal Extension Service		X				
Economic Research Service	X					
Consumer and Marketing Service						
Division:						
Poultry						X
Processed Meat Inspection						X
National Agricultural Library		X				
Office of Information			X			
Office of the General Counsel				X		
Research Program Development and Evaluation Staff	X					

UNITED STATES DEPARTMENT OF AGRICULTURE
Funds Available for Pesticide Research and Related Activities
by Agency, Fiscal Years 1966, 1967, and 1968 Estimated
(Thousands of Dollars)

Agency	1966			1967			Estimated		
	Program:	Facili- ties	Total	Program:	Facili- ties	Total	1968	Total	
Agricultural Research Service.....	76,200	8,307	84,507	80,214	1,653	81,867*	86,848		
Agricultural Stabilization and Conservation Service.....	26	-	26	28	-	28	29		
Cooperative State Research Service.....	9,330	160	9,490	9,409	-	9,409	10,110		
Consumer and Marketing Service.....	200	-	200	300	-	300	400		
Economic Research Service.....	508	-	508	511	-	511	512		
Federal Extension Service.....	4,203	-	4,203*	4,360	-	4,360*	4,400		
Forest Service.....	17,727	1,168	18,895	18,184	857	19,041	19,412		
National Agricultural Library.....	206	-	206	333	-	333	395		
Office of Information.....	80	-	80*	79	-	79*	80*		
Research Program Development & Evaluation Staff.....	15	-	15*	15	-	15*	15*		
TOTAL	108,495	9,635	118,130	113,433	2,510	115,943	122,201		

* Includes resources drawn from a \$250,000 intra- and interdepartmental pesticide coordination fund first appropriated to the Department in Fiscal Year 1965.

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UNITED STATES DEPARTMENT OF AGRICULTURE
Funds Available for Pesticide Research and Related Activities
By Target, Fiscal Years 1966, 1967, and 1968 Estimated
(Exclusive of Construction)
(Thousands of Dollars)

TARGETS	1966	1967	1968 Estimates
1. Fundamental Biology	14,452	16,307	17,581
2. Improved Means of Nonpesticidal Control.....	24,155	23,702	25,304
3. Improved Pesticide Use Patterns	12,665	12,937	13,189
4. Toxicology, Pathology, Metabolism, & Fate.....	4,953	4,942	5,358
5. Economics of Pest Control, Use, Supply, and Requirements.....	650	662	673
6. Pest Control.....	43,728	45,926	46,066
7. Monitoring.....	767	886	1,286
8. Regulation.....	2,621	3,284	3,698
9. Information, Education, & Coordination.....	4,504	4,787	4,900
TOTAL	108,495	113,433	118,045

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Service

Funds Available for Pesticide Research Facilities by Agency
Fiscal Years 1966 and 1967
(Thousands of dollars)

AGENCY AND FACILITY

Fiscal Year
1966

Fiscal Year
1967

Agricultural Research Service:

Facilities for livestock insects and toxicological and pathological effects of pesticides on livestock, College Station, Texas

(Total cost--\$3,250,000) \$ 2,990

Facilities for the control of plant diseases, nematodes, and insects, Beltsville, Maryland (Total cost--\$3,225,000)..... --

Insect attractants and basic research laboratory, Gainesville, Fla.-- includes \$40,000 for marketing research (Total cost--\$2,000,000).... 1,840

Weed research laboratory, Stoneville, Mississippi (Total cost--\$1,700,000)..... 1,564

Cotton disease research facilities, College Station, Texas

(Total cost--\$700,000)..... 644

Western cotton insects research facilities, Tempe, Arizona

(Total cost--\$700,000)..... 644

Facilities to develop procedures and methods to avoid water pollution, Durant, Oklahoma..... 500

Cereal rust laboratory, St. Paul, Minnesota

(Total cost--\$650,000)..... 50

Grain marketing research laboratory, Manhattan, Kansas (1/3 of laboratory relates to pesticide research) (Total cost pesticide related--

\$1,128,000)..... 75

Plans for construction of a Grassland Laboratory in the Southwest

(approx. 79% of laboratory relates to pesticides research) (Total

cost--pesticides related \$1,422,000)..... --

*** *** ***

AGENCY AND FACILITY		Fiscal Year 1966	Fiscal Year 1967
Laboratory for expanded registration and enforcement activities under the Federal Insecticide, Fungicide, and Rodenticide Act, Beltsville, Md. (Total cost--\$1,250,000).....		--	--
TOTAL, ARS Research Facilities		\$8,307	\$1,653
Cooperative State Research Service:			
Grants to State Agricultural Experiment Stations.....		160	--
TOTAL, Cooperative State Research Facilities..		\$ 160	--
Forest Service:			
Berkeley, California, construction, chemical storage facility...		--	--
Athens, Georgia, design and specifications, Forestry Science Laboratory....		25*	--
Bottineau, North Dakota, construction, greenhouse facility.....		13*	--
Fort Collins, Colorado, construction, headquarters, office and laboratory.....		218*	--
New Haven, Connecticut, construction, Forest Insect and Disease Laboratory.....		850	--
Olustee, Florida, construction, Naval Stores and Temple Production Laboratory.....		45*	--
Olympia, Washington, design and specifications, Silverculture and Animal Problems Laboratory.....		17*	--

TABLE 3 continued -

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AGENCY AND FACILITY		Fiscal Year 1966	Fiscal Year 1967
Athens, Georgia, construction, Forestry Science Laboratory.....		\$ --	\$ 390*
Corvallis, Oregon, design and specifications, Forestry Science Laboratory.....		--	170*
Delaware, Ohio, design and specifications, Insect and Disease Laboratory.....		--	72
Olympia, Washington, construction, Silverculture and Animal Problems Laboratory.....		--	225*
TOTAL, Forest Research Facilities		\$1,168	\$ 857
* Portion of total cost applicable to pesticide- related research.			
TOTAL USDA RESEARCH FACILITIES.....		\$9,635	\$2,510

*** *** ***

E X A M P L E S O F P R O G R E S S

TARGET I

TO GAIN KNOWLEDGE OF THE TAXONOMY, BIOLOGY, ECOLOGY,
PHYSIOLOGY, PATHOLOGY, METABOLISM, AND NUTRITION
OF PESTS AND HOST PLANTS AND ANIMALS

General

National Fungus Collections. The National Fungus Collections is indispensable for the dependable identification of plant pathogens. During the year 41,349 reference specimens were added and 1,449 specimens were loaned for research study by specialists of the United States and nine foreign countries. (I) Beltsville, Md.

Physiological Study of Indian-meal Moth. Studies on the metabolism of the Indian-meal moth have shown respiration decreases by 90 percent as the newly molted last instar larva develops to a 1-2-day old pupa, but is subsequently restored to 50 percent in the newly emerged adult. During the last larval instar, when lipid accumulation is most intense, cytoplasmic enzymes responsible for generating reduced nicotinamideadenine dinucleotide phosphate achieve their highest activity. During the same period, alpha-glycerophosphate dehydrogenase and aconitase activities decline, while citrate-cleavage enzyme and malic dehydrogenase activities remain unchanged. Neutral lipids are primarily accumulated during the last larval instar before their utilization in the pupa and adult. Phospholipid content decreases during larval development but is restored during the pupal period. During embryogenesis neutral lipids are extensively catabolized concurrent with an increase in phospholipid content. (I) Savannah, Ga.

Biology of Stored-grain Moths. An endogenous circadian rhythm can be entrained into the Indian-meal moth to produce peaks of emergence, mating, and oviposition. By varying the onset of light and dark cycles, it is possible to synchronize populations of emerging adults into daily peaks and also to predict when the highest frequency of mating and oviposition will occur. Utilization of this information in the timing of pesticide treatments could materially increase the effectiveness of space treatments in food storage facilities. (I) Savannah, Ga.

Ecological Control of Aquatic and Bank Weeds. A survey of 16 irrigation projects in Washington was made to discover and select the most desirable areas, plant communities, and species for research on ecological and physiological responses of aquatic and bank weeds to plant competition, soil and water nutrients and other aspects of environment. Water plantain, which usually grows only 4 to 6 inches tall in deep canals, appeared to compete strongly with the much taller and more obstructive pondweeds. Canals in a 50 to 100 square mile area do not support appreciable submersed weed growth. These situations offer fertile fields for future research. (I) Prosser, Wash.

New Method for Evaluating Nematode Resistance. A test tube technique was developed for evaluating nematode activity in plant roots, and resistance in plants. The new method is cheap and precise, and results are available 3 days after the roots are inoculated with nematodes. Much new information has been obtained on nematode tolerance, hypersensitivity, resistance, and susceptibility of tomato lines. This type of information is not easily obtained by conventional methods used by plant breeders. (I) Beltsville, Md.

Animals

Submicroscopic Structure of Coccidia Observed. Coccidia infected intestinal tissues of calves were used for electron micrography. The first micrographs were made of an Eimerian, E. alabamensis, located inside the nucleus of the host cell from the intestine of a calf. Residual bodies, lipid-like structures, mitochondria, endoplasmic reticulum, and plastic granules ("labyrinth-like bodies" of Scholtyseck) that eventually form the cocyst wall were observed. Electron micrographs were made with enlargements of up to 150,000 times. (I) Auburn, Ala.

Propagation of Swine Ascaris Larvae in Vitro. The large roundworm, Ascaris lumbricoides, is one of the most common and injurious helminth parasites of swine. Its ubiquity and close relationship with the large roundworm of man have made it a favorable subject in many areas of biological research. Although studied intensively by parasitologists all over the world, the several stages of this nematode have heretofore been recovered only from animal hosts. All previous attempts to grow larvae to identified stages in culture have failed. By applying techniques developed in growing an obligate tissue parasite (the swine kidney worm) in vitro, swine ascarids have now been grown to advanced larval stages in complex nutrient media used with cultures of swine kidney cells. From observations made during close and continuous study of developing larvae, possible only during in vitro studies, it was found that certain previously described details of structure and life cycle were inaccurate. The validity of these new findings has subsequently been proved by animal experiments. (I) Beltsville, Md.

Equine Piroplasmosis. The two species of Babesia (piroplasms) known to affect equines and produce piroplasmosis have been identified in equines in Florida. One of them, Babesia caballi, was discovered in August 1961, the other, B. equi, was found in March 1965. Studies have been directed largely toward identification and differentiation of these parasitic infections. Studies of fixed, stained blood films and observations of living parasites in freshly drawn blood have led to a more complete understanding of the intraerythrocytic development of the parasites. The complement fixation test has proved to be the most dependable serologic test for differential diagnosis. (I) Beltsville, Md.

Tick Transmission of Piroplasmosis. Larvae of the tick, Dermacentor nitens, obtained from the enzootic areas in Florida, transmitted B. caballi to horses on 5 separate trials. Developmental forms of the parasites were observed in the egg, larvae, nymph and adult stages of this tick. (I) Beltsville, Md.

Field Crops

Witchweed in Corn and Sorghum. A stimulant released by the roots of growing cotton will cause the seed of the corn parasite witchweed to germinate. Research revealed that the stimulant from cotton consists of two related chemical compounds. One of the compounds has been arbitrarily named strigol, and the other appears to be a O-acetyl derivative of strigol. Strigol has been purified to the crystalline form, and research is underway to complete the identification of its structure. It is active in stimulating the germination of witchweed seed at a concentration of 6 parts per trillion. The progress in this research encourages hope that stimulants for other weed seed can be developed. (E) Research Triangle Institute.

Stem Rust Epidemiology, Initial Rust Infection. Expanded studies indicate that initial rust infections of susceptible wheats develop when spores are washed from the air by early spring rains and fall on wheat plants. Infection from this source can have a more significant impact on later rust development than spores brought in later by winds from southern grain areas. (I) St. Paul, Minn.

Biology of Phytophthora Rot in Soybeans. Investigation of reduced light on susceptibility of soybeans inoculated with Phytophthora megasperma var. sojae indicated no increase in susceptibility. Resistant varieties became susceptible if the plants were exposed to a 3-day 43°C preinoculation treatment. Resistance in a susceptible variety could be induced by inoculating with the nonpathogenic fungus P. cactorum 3 days prior to inoculating with P. megasperma. Two races of P. megasperma var. sojae were identified, distinguishable by their physiologic specialization. (I) Urbana, Ill.; Stoneville, Miss.

Pink Bollworm Sex Attractant Isolated and Synthesized. The sex pheromone has been isolated in pure form from the pink bollworm, its chemical structure shown to be 10-propyl-trans-5,9-tridecadienyl acetate (named propylure), and it has been synthesized in the laboratory. The pure synthetic material is highly attractive and stimulatory to adult male moths in the laboratory. High concentrations of either purified natural lure or synthetic propylure were found to be necessary to lure males into field traps. When an inactive extract of female moths is added to either the natural or synthetic propylure the mixture is as active as crude natural lure in attracting male moths to field traps. The chemical nature of this activator is being investigated. (I) Beltsville, Md.

Mode of Infection- Verticillium Wilt. The mode of infection and colonization of the cotton plant by the verticillium wilt fungus has been satisfactorily worked out. The root of the plant serves as an inoculum source and conidia move at random throughout the plant in the xylem fluid. Tolerance to the disease appears to be associated with the smaller number of conidia produced in the root system of tolerant plants resulting in a lower inoculum potential in the plant. Studies on the movement of conidia showed that a plant 40 inches tall could be colonized to the topmost leaf within 24 hours. (I) Beltsville, Md.

Nature of Root and Leaf Diseases of Tobacco. Bacterial wilt susceptible tobacco cuttings were rendered resistant to a virulent strain of the pathogen Pseudomonas solanacearum if inoculated with an avirulent strain at least 24 hours before inoculating with the virulent strain. This suggests that susceptible cuttings react to the avirulent strain by forming a resistant mechanism which is effective against the virulent strain. (I) Oxford, N. C.

Biochemistry of Parasitism - Sugarbeet Leaf Spot. Phenolic substances in sugarbeet leaves are associated with resistance to the leaf spot pathogen. Progress has been made in developing a chemical procedure for determining the phenolic substances, thereby providing a simple laboratory test for the selection of resistant segregants in sugarbeet populations. (I) Fort Collins, Colo.

Horticultural Crops

Parasitism of Codling Moth Eggs. Laboratory studies showed that non-viable eggs produced by normal codling moth females mated to irradiated males could sustain Trichogramma populations, suggesting possible use of sterile eggs distributed in orchards to support constant population development of the parasites. Parasites were produced by 84% of these eggs compared to 95% of viable eggs. (I) Yakima, Wash.

Seed Transmission of Spindle Tuber Virus. The potato spindle tuber virus (PSTV) was recovered from two potato plants grown from true seed. PSTV infection was determined by indexing on Rutgers tomato plants. A large-scale test is needed to confirm this finding. Even .1 percent seed transmission would be of great importance to potato breeding programs. No other potato virus is known to be transmitted through true seed. (I) Beltsville, Md.

Pollen Necessary in Cucumber Beetle Diet. Pollen was found to be a necessary ingredient in the diet of spotted cucumber beetles for production of a male lure by the female beetles. Extracts of the attractant produced by the spotted cucumber beetle were effective for less than one hour, compared to several days for the attractant produced by the banded cucumber beetle. (I) Charleston, S. C.

Feeding Stimulants for Cucumber Beetle. Studies showed that four chemicals from the cucurbitacin group were feeding stimulants for the banded cucumber beetle but apparently not for the striped cucumber beetle. The former showed a strong biting response to filter paper impregnated with the chemicals. (I) Charleston, S. C.

Epidemiology of Grape Viruses. Eight viruses occur in grapes in California. Their detection by indicator methods, the effects of virus complexes, establishment of virus-free stocks and heat treatments for inactivation of virus are the main problems in the research work. A 28-day heat treatment at 100°F inactivated fanleaf virus in the tips of grape plants. A 45-day heat treatment inactivated astroid mosaic and yellow vein viruses in stem tips of grapevines and a 56-day treatment freed stem tips in most cases of leaf roll virus. A 60-95 day treatment inactivated corky bark in some stem tips of grapes. (I) Davis, Calif.

Forests

Differentiating Dead and Living Pine Tissues. Intracellular localization of individual enzymes in frozen white pine tissues may permit precise demarcation of living tissues wherein these enzymes are operative. Proper analysis of the effectiveness of antibiotic control of blister rust lies in the knowledge of whether tissues in and adjacent to cankers are living or dead. (I) Moscow, Idaho.

Annosus Root Rot - Forest Trees. Serological comparisons were made among isolates of Fomes annosus. All isolates from the United States were identical. Isolates from New Zealand differed slightly from the United States isolates while the Indian and Japanese isolates were almost identical but different from those from the United States and New Zealand.

The presence of these physiological races within F. annosus may be of considerable significance in developing preventive and control measures.
(I) Durham, N.C.

Bacteria in Decay - Living Trees. Preliminary results from a study of the patterns of discoloration and decay in living trees following inoculation with decay fungi revealed that a succession of organisms and organism interactions occurred. The decay fungi invaded only through tissues first occupied by bacteria and non-hymenomycetes. The results give added importance to the role that pioneering organisms have on decay.
(I) Durham, N. H.

Additional information may be found on page A-1.

TARGET II

TO IMPROVE AND DEVELOP MEANS OF CONTROLLING PESTS BY NON-PESTICIDAL METHODS

General

Resistant Genes in Avena sterilis. An extensive collection of the hexaploid Avena sterilis from Israel (PL 480 research) has new and different genes for resistance to virulent races of crown rust, stem rust, soil-borne mosaic, and barley yellow dwarf. The genes obtained from this source are now being transferred into breeding stocks of desirable agronomic types. (I) Tifton, Ga., Aberdeen, Idaho; Mayaguez, Puerto Rico.

Mosquito Oviposition Lure. A chemical substance possessing a high degree of attractiveness to ovipositing female mosquitoes, Culex salinarius, Coq. has been isolated. This attractant material is of protein origin, apparently derived from decaying plant tissues. Early in the investigation it was observed that concentrated straw infusion contained an attractant factor. In field and laboratory tests, water suspensions containing a proteinaceous extract attracted more ovipositing mosquitoes than did the raw infusion, and significantly more than the native habitat. The oviposition lure which has been isolated should be very useful in the future in highly selective control measures for the mosquito, C. salinarius. The results indicate the way to develop similar lures which would be attractive oviposition sites for other species of mosquitoes. (E) Del. Agr. Exp. Sta.

Introduction of Foreign Plants. An exploration in the USSR for forage legumes and grasses was especially productive. Some 700 collections were obtained directly from remote regions of Central Asia and a similar number of requests were left with Soviet scientists. This germ plasm is now being evaluated as a rich new source of insect and disease resistance for many of our most important forage and range species. (I) Beltsville, Md.

Sex Attractant Identified. The sex attractant of the female cabbage looper moth, has been isolated and identified as - CIS-7 dodecen-1-d acetate. The chemical structure of the attractant was verified by synthesis of the compound. (E) Ala. Agr. Exp. Sta.

Nocturnal Insect Sensing. Studies are underway to determine whether some insects may use infrared radiation for locating mates or communicating with one another. Equipment has been developed which will measure CO₂ produced by insects, to study physiology and metabolic response related to infrared radiation. (E) Univ. of Mich.

Attractants for Stored-product Moths. It has been established that male Indian-meal moths and almond moths are attracted by the natural attractant produced by the females of each respective species. There is a cross attraction between the two species, but the attractants are apparently different in structure since the males were considerably more responsive to the attractant obtained from females of their own species. Isolation, identification, and synthesis of the attractants are in progress. (E) Univ. of Ga.

Physical Methods of Controlling Stored-product Insects. Electrophysiological studies involving probing the retinas of various stored-product insects showed maximum response occurs in the green light region. Exposure to pulsed 6943 Å laser light of 2- and 5-joule intensity killed stored-product insects. Egg laying by Indian meal moths was reduced 50 to 60 percent when exposed 3 or 4 days in a 150-cu.-ft. reverberation chamber to 2-kilocycle sound waves or to a continuous slow-swept frequency of 0 to 2 kilocycles. When placed under stress, adult red flour beetles may emit a sound with a frequency of 5.5 to 6.0 kilocycles. Gamma irradiation of 20 to 25 krad appears capable of eliminating infestations of stored-product insects. Moths appear to be more resistant to radiation than beetles. A newly designed trap was found very effective for capturing almond and Indian-meal moth larvae in stored commodities. (I) Savannah, Ga.

Haltica Carduorum to Control Canada thistle. A flea beetle, Haltica carduorum, which attacks Canada thistle in Europe, was released in Canada after adequate tests proved it would complete its development on the thistle only. Further proof of the beetle's specificity was obtained by means of an additional two-year study at Albany, California. The beetle was released at ten locations in 4 States in April, May, and June 1966. (I) Albany, Calif.

Hylemya Seneciella to Control Tansy Ragwort. The larvae of a seed-head fly, Hylemya seneciella, attack tansy ragwort seeds in Europe, markedly reducing the rate of spread of this plant. Adequate research in Europe has shown that the fly is host-specific. Approximately 16,000 puparia of the fly were gathered in the vicinity of Paris, France, in 1965, and adult flies from these puparia were released in Oregon and California, in June 1966. (I) Albany, Calif.

Biological Control of Aquatic Weeds with Snails. A large fresh water snail Marisa cornuarietis was given a severe test in 1965 for controlling aquatic weeds. Within 1 year after introduction of 3,000 adult snails into a small pond which connects to the experiment station canal system, young snails and egg masses were found attached to aquatic vegetation in all canals. A pump failure in the summer of 1965 caused complete drying of all canals and apparently the death of all snails. Water remained in only the small pond. However, by December 1965 snails were again present in all areas of the canals. (I) Fort Lauderdale, Fla.

Biological Control of Aquatic Weeds with Fish. Silver dollar fish fed readily on five species of pondweed in auaria tests. Elodea was less palatable but eventually eaten. Grazing was limited at water temperatures below 70°F. The rate of grazing increased rapidly at higher water temperatures. The Mylossoma argentum species of dollar fish was more aggressive in its feeding habits than Metynnis roosevelti. (I) Davis, Calif.

Biological Control of Weeds with Flea Beetle. At a one-fifth acre site near Jacksonville, Florida, where the alligatorweed flea beetle (Agasicles n. sp.) was released in 1965, there has been a remarkable expansion of the population of that insect. The weed on the site has been completely defoliated, leaving only bare, badly-chewed stems. At the end of May, the beetles had moved more than a mile up and down the Ortega River from the release site. (I) Albany, Calif.

Vaccine for Anaplasmosis Control. The first successful vaccine for the control of anaplasmosis in cattle has been developed and is now available commercially to practicing veterinarians. The vaccine will be particularly useful in localities having a high incidence of this serious blood parasitic disease of cattle and it is anticipated that in these areas reduced reliance will be placed on chemicals for prevention and treatment. The vaccine reduces severity of anaplasmosis in infected cattle but does not prevent spread of the parasite. (E) Okla. Agr. Exp. Sta.

Animals

Parasites of Face Fly. Research has shown that new parasites of the face fly, a serious pest of cattle, offer promise as biological control agents. One particularly promising parasite, Aleochara tristis, a staphylinid beetle, introduced from France, early in 1965, was successfully colonized, and released at Lincoln, Nebraska. It survived the winter in good numbers. Investigations have also revealed several native insect parasites and a nematode of face flies. (I) Lincoln, Nebr.

Horn flies. Horn flies on dairy cattle were effectively controlled with an electrochemical device which avoids the risk of contamination of cattle, milk, and milking equipment. BLB fluorescent lamps are installed in

box-like containers and insecticide impregnated gauze protected by hardware cloth placed in front of the lamps. When units are installed on both sides of entrances, horn flies are attracted to the lights, contact the treated gauze and die in a few minutes. When operated in total or semidarkness, these devices reduced large horn fly populations by 90 to 95% within 7 to 10 days and maintained effective control thereafter. Studies are underway to create a semidark environment at entrances to barns to render the units effective at all hours. (I) Kerrville, Tex., and Beltsville, Md.

An Improved Anthelmintic for Swine. The effectiveness of Dichlorvos has been established for the control of swine parasites. A particularly important improvement in the new product is its timed release of the active chemical. Controlled release allows the chemical to reach parasites in every part of the digestive tract. Residues of the drug do not accumulate in body tissues. Dichlorvos is effective in controlling a number of different kinds of important parasites of swine. (E) Wis. and N.C. Agr. Exp. Stas.

Antigens for Detecting Kidneyworm Infected Swine. Negatively charged antigens in extracts of kidneyworms were separated by their migration towards the positively charged pole in the process of electrophoresis through agar. These components detected antibodies in sera from experimentally infected swine earlier in the course of an infection than did unfractionated extracts. Further the components did not react with sera from noninfected swine. Tests were carried out by the agar double-diffusion test and the immuno-electrophoretic test. This is a major step toward development of a test for detecting kidneyworm parasitism in swine. (I) Beltsville, Md.

Field Crops

Extract From Female Grain Moths Attracts Males. A sex attractant of the Angoumois grain moth can be obtained by simple extraction methods. The material attracts males and stimulates their mating behavior. (E) Kan. Agr. Exp. Sta.

Cereal Leaf Beetle. 7,150 wheat varieties were screened for cereal leaf beetle. Eighteen spring varieties had resistance to both the larvae and adult forms. Resistance has been introduced into genetic and breeding stocks. (E) Mich. Agr. Exp. Sta.

Hessian Fly Resistant Wheat. Wheat acreage planted to Hessian fly resistant varieties continues to expand. Surveys conducted during the 1965-66 season indicate approximately 10,000,000 acres of Hessian fly resistant varieties are now being grown in the United States. A new Hessian fly resistant soft red winter wheat, Ben hur, was developed and released in Indiana. This wheat besides being resistant to the major wheat diseases, is resistant to the new Hessian fly race B which is threatening the wheat crop in southern Indiana. The variety Ben hur is also resistant to race A. (I) Lafayette, Ind.

Resistance to Corn Viruses. Resistance has been found to stunt and maize dwarf mosaic and expanded research is directed toward additional sources of resistance and more basic information on the viruses. In addition to stunt and maize dwarf mosaic, a third virus of corn has been found. It resembles wheat streak mosaic and can be transmitted mechanically or by a mite. Plans have been made to build and provide additional facilities and personnel for intensive studies on the corn viruses. (I) Wooster, Ohio.

Seed Disinfection by Aerated Steam. Aerated steam eradicated diseases in seed of several species of grasses and legumes. Agrostis canina seeds were least tolerant, and sudangrass seeds were the most tolerant of several species of grasses studied. Pathogens affecting grass seeds also vary in tolerance to steam treatment. Spores of smut fungi in indurate spore masses were killed in 20 minutes at 140°F. The pathogen causing blind-seed disease of ryegrass, was killed in pseudosclerotia by 20 minutes exposure at 140°F. Sclerotinia borealis in sclerotia and grass seed nematode in bentgrass seed galls were also eradicated by the same treatment. (I) Corvallis, Ore.

Grazing Lands and Turf - Broomsedge Control. Management practices were as effective as herbicidal treatments or mechanical renovation for control of broomsedge (Andropogon virginicus L.) in pastures. After three or four seasons of fertilizing, mowing (twice each season) and grazing a broomsedge infested pasture, the broomsedge stand was reduced and dallisgrass stand was increased. Cattle preferentially grazed broomsedge where nitrogen was applied. Nitrogen fertilization increased protein content of young growth about 50 percent. Mowing the extra growth of broomsedge at least twice during the season kept it in a vegetative condition that was palatable to cattle. (I) State College, Miss.

Mechanisms of Resistance in Alfalfa. Techniques were developed to determine how alfalfa resists disease and insect attack. One of the techniques for stem nematode studies utilized a single nematode mounted in a drop of agar which could be observed microscopically for behavior in contact with a seedling. This technique is being used to study attraction and repulsion of nematodes by plants and mechanisms by which nematodes enter plants. (E) N. C. Agr. Exp. Sta.

Release of Disease Resistant Alfalfa Variety. A new variety of alfalfa named Delta was released in cooperation with the Mississippi Agricultural Experiment Station. In plantings on heavy clay soil in the Yazoo-Mississippi Delta area, Delta remained productive for 5 years. This appears to be due in part to its tolerance to root and crown rots, leaf-hopper yellowing, and certain leaf spot diseases. The new variety was equal to or slightly better than standard varieties in hay yield. (I) Stoneville, Miss.

Parasite control of Pea Aphid. In the southern States the introduced parasite Aphidius smithi has become the dominant species in the early season

control of the pea aphid. Moreover, during mid-June, pea aphid collections in eastern Ohio, Northern New Jersey, southern New York and in Oregon, for the first time yielded high percentages of the parasite, indicating that it is able to withstand low winter temperature and that it is becoming an important factor in pea aphid control over much of the alfalfa producing area of the United States. (I) Moorestown, N.J.

Breeding Soybeans Resistant to Phytophthora Rot. Semmes, a new soybean variety, with a high degree of resistance to phytophthora rot was released. Semmes is recommended for planting in the clay soils of the Delta region. Good stands are obtained on the poorly drained clay soils where presently grown varieties may be almost completely eliminated. (I) Stoneville, Miss.

Peanut Pod Rot Suppression Without Use of Pesticide. Peanut pod rot can be suppressed and yield and market quality of pods increased by applying gypsum, or landplaster, at the rate of 1,500 to 2,000 pounds per acre instead of the usual 800 pounds per acre. Calcium has been shown to be the ingredient in the gypsum which is active in suppressing pod rot. (I) Holland, Va.

Controlled Atmospheres for Stored-product Insect Control. Purging grain, peanuts, and possibly other agricultural commodities with nitrogen or carbon dioxide while in storage appears very promising as a nonpesticidal insect control or preventive measure. In laboratory tests, insect control in peanuts was obtained within 2 to 3 days, which is as short or a shorter time than required by certain fumigants, and the viability and quality of the stored product was maintained as high or higher than when stored under ambient conditions. (I) Savannah, Ga.

Nematode and Wilt-resistant Cotton Variety. In cooperation with Louisiana State University, a new cotton variety "Bayou" was released with high resistance to the cotton root-knot nematode and Fusarium wilt. (I) Baton Rouge, La.

Bacterial Blight Immunity in Cotton. Genetic factors have been identified, the inheritance worked out, and breeding methodology is known for the transfer of immunity to bacterial blight in cotton. Immunity factors were obtained from introduced germ plasm. (I) Stillwater, Okla.

Root-knot Nematode Resistance in Cotton. New techniques have been developed which permit the rapid accurate evaluation of germ plasm for root-knot nematode resistance in the seedling stage. The method permits screening of large populations of introduced and domestic germ plasm as well as segregating populations in a very short period of time and requires a minimum of space. Breeding for resistance will be accelerated by the development. (I) Auburn, Ala.

Breeding Burley and Dark-fired Tobaccos Resistant to Root and Leaf Diseases. Kentucky 170, a dark-fired tobacco variety, has been released. KY 170 is practically immune to the black root rot disease from Nicotiana debnezi. This variety is also resistant to mosaic and wildfire, produces 10 percent

greater yield than the popular variety KY 151, and is excellent for snuff manufacture. It was available for farm planting in 1966. (I)
Lexington, Ken.

Tobacco Hornworm - light traps. Island of St. Croix, V.I., has been covered with 240 insect light traps (approximately 3 per square mile) to determine possibility of controlling tobacco hornworms with such equipment where infiltration from adjacent areas will be eliminated. Efficiency of various electric insect trap designs and suppression of population will be determined. (I) Kingshill, St. Croix, U.S., V.I.

Physical Method for Control of Cigarette Beetle. Basic data was acquired on temperature, absolute pressure, and exposure time required for use of a vacuum-steam flow system for controlling tobacco moths in processed tobacco. Several processing plants are now using this system for insect control rather than using pesticides. (I) Richmond, Va., ARS.

Breeding Sugarbeets Resistant to Virus Yellows and Root Disease-Nematode Complex. Largely because of the difficulty in obtaining uniformly reliable inoculum, the breeding of sugarbeet for resistance to the cyst nematode, *Heterodera schachtii*, has been difficult. The recent development of a simple chemical treatment that induces hatching of the eelworms from the cyst, for the first time provides precise inoculum to screen for resistance. This will facilitate the development of resistant varieties that would remove the need for soil fumigation. (I) Salinas, Calif.

Horticultural Crops

Evaluation of Disease Resistance in Plant Introductions. Plant breeders in all crop categories benefited by the identification of introductions having superior phenotypic responses to incidences of one or more diseases. Apple, pear, and grape introductions are being indexed for the presence of latent viruses for the first time as part of the quarantine procedure. Detection of stone fruit viruses is more advanced. Sixty-five virus-free introductions were cleared for release. Of the foreign introductions of stone fruits indexed to date, 52 percent have been infected. (I)
Glenn Dale, Md.

Decay Control by Heat Treatments. Research with hot water dips, as a substitute for postharvest chemical treatments, has resulted in commercial use of the method for reduction of decay during marketing in fresh peaches, mangos, and cantaloupes. Other commodities for which the method shows promise are bell peppers, blueberries, cranberries, apples, and citrus fruits. Temperatures and exposures vary by commodity from 120° to 135° F. and from 1/2 to 3 minutes. (I) Beltsville, Md.; Orlando, Fla.; Miami, Fla.; and Harlingen, Tex.

Oriental Fruit Fly Eradication. The sterile male technique was used to eradicate an outbreak of oriental fruit flies on the island of Guam. About 8 million flies were released over a 5-week period to accomplish this eradication. (I) Honolulu, Hawaii.

Insects Repelled by Aluminum Foil. Aluminum foil mulches repelled aphids, banded cucumber beetles, and Mexican bean beetles from squash and beans. Flying aphids were reduced 93% in squash planting with aluminum mulch and only 4% of the mulched plants were infected with aphid-transmitted viruses, compared to infection of 69% of the check plants. Yield was increased six-fold in the aluminum plots. (I) Beltsville, Md., and Charleston, S. C.

Non-Chemical Control of Cabbage Looper. Trials of blacklight insect traps for protection of vegetables from damage by cabbage looper were initiated. A light trap was modified to attract the looper moths with ultraviolet, expose them to a chemosterilant material and release them again to compete in the natural population. This substantially reduced reproduction rates in laboratory tests, but will require design changes for successful field use. Placement of live virgin female looper moths in the vicinity of light traps was found to increase collections of male moths an average of ten-fold. The pheromone producing this response has been synthesized and preparations for a large-scale test of light traps plus pheromone for protecting lettuce are being made at (I) Red Rock, Ariz.; Riverside, Calif.

Banded Cucumber Beetle Resistance in Sweetpotato. A variety of sweetpotato resistant to the banded cucumber beetle larvae in Louisiana (L3-64) was also resistant to several other species of soil insects. (I) Charleston, S. C.

Tomato Variety Enterpriser Released. B96, an early, determinate, multiple disease-resistant, crack-resistant tomato line was released to the seed trade as the variety Enterpriser. This variety performed well in the Southern Tomato Exchange program during a 3-year test period. The last 2 years in this program it ranked among the first three of all entries entered in the yield trials. Many southern breeders have used Enterpriser (B96) in their development programs for its disease resistance, to improve fruit set, and because of the smallness of the blossom scar. (I) Beltsville, Md.

Disease Resistance in Dry Beans. In Washington, two new Red Mexican bean varieties, "Bigbend" and "Coulee," were released to western bean growers. Both resist the principal seedborne viruses and curly top. They are earlier maturing and shorter vined and less subject to Sclerotinia wilt than the present commercial varieties. Progress continued in the selection of fusarium- and multiple virus-resistant dry beans in four varietal types. Many selections were made among lines with twice the yielding ability of root rot-susceptible commercial varieties when grown in Fusarium-infested soil. (I) Prosser, Wash.

Codling Moth - Sterile Male Release. Experimental sterile male releases were used instead of insecticides to control the codling moth in approximately

17 acres of apple orchards in Washington. An overflooding ratio as high as 400 sterile moths to 1 wild moth was achieved. Worm entries were comparatively rare in the release orchard. With the reduced amounts of insecticide employed in the orchard, marked improvement in the effectiveness of biological control of other pests was noted. (I) Yakima, Wash.

Breeding Nematode Resistant Grape Rootstocks. Rootstock selection US 16-154 was named Harmony and released to growers and nurserymen. Hardwood cuttings of Harmony root readily. The rootstock is also adapted to the bench graft method of propagating vinifera varieties. Harmony is recommended for trial as a rootstock with the Thompson Seedless variety for wine and raisin production, in soils where nematodes or phylloxera are a problem. (I) Fresno, Calif.

Breeding Root Rot-resistant Strawberries. Strawberry selection US-Ore. 2575 was introduced under the name of Hood. It is a processing type berry that is particularly good in frozen pack for the preserve trade. Hood is resistant to mildew and verticillium wilt and is tolerant to red stele and viruses. (I) Corvallis, Ore.

Forests

Bark Beetle Sex Attractants. The sex attractant of the bark beetle, Ips confusus, has been synthesized. Tested in the field, the synthetic materials are as effective as the natural compounds in luring the beetles. This is the first time that a bark beetle sex attractant has been synthesized and it may well open the door for similar breakthroughs with other highly destructive bark beetle species. (E) Stanford Research Institute, Univ. of Calif., and Calif. Agr. Exp. Sta.

Additional information may be found on page A-18.

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TARGET III

TO DEVELOP SAFER AND MORE EFFECTIVE PESTICIDE USE PATTERNS,
FORMULATIONS, AND METHODS OF APPLICATION; AND IMPROVED
METHODS FOR DETECTING, MEASURING AND ELIMINATING OR
MINIMIZING PESTICIDE RESIDUES IN PLANTS, ANIMALS
AND THEIR PRODUCTS, AND IN THE ENVIRONMENT

General

Non-residue fumigant promising for disinfestation of rail cars. In preliminary tests, aluminum phosphide shows promise as an economical and effective means of controlling insects in rail cars. This is a difficult problem with presently available pesticides. All test insects were killed in experimental shipments of rail cars containing packaged cereal products and loaded bulk hopper cars treated with 1.5 aluminum phosphide pellets per 1,000 cu. ft. of space. No residues were found on any of the processed or bulk commodities. (I) Manhattan, Kan.

Greenhouse Azaleas Pruned Chemically. Growing points of azalea shoot tips can be selectively inhibited or killed by foliar applications of aqueous emulsions of the lower alkyl esters of C₈ to C₁₂ fatty acids and C₈ to C₁₁ fatty alcohols without damage to the rest of the plant. Axillary shoots develop on the sprayed plants at nearly the same time and usually in greater numbers than on manually pruned plants. These chemicals inhibited the terminal meristem without damaging the axillary meristems, foliage, and stems of a wide range of plants. (I) Beltsville, Md.

Multiple Pest Control by Pesticides. Spectacular increases in plant growth and yields, and control of nematodes, weeds, and pathogenic fungi, were obtained by improved application methods and selected mixtures of specific pesticides, at reduced dosage levels and application costs. (I) Logan, Utah; Baton Rouge, La; Tifton, Ga.

New, safer mothproofing treatment. Several quaternary ammonium (QA) compounds show outstanding promise for application to woollens to prevent damage by moths and carpet beetles. These compounds are safe for use on clothing for humans

and on other fabric items. Under current research, it was found that not all QA compounds are adsorbed by wool at the same rate. In general, (1) increasing immersion bath temperature and pH increases add-on, (2) increasing immersion time only slightly increases add-on, and (3) increasing the concentration of the QA in the bath greatly increases add-on but has little effect on the percentage of exhaustion from the bath. A new program will develop data for effective application for the one QA compound designated as most promising for commercial development. (I) Savannah, Ga., and (E) Harris Research Labs.

New fumigant for processed foods. Complete kill of test insects in various packaged foods was obtained with 165 pellets or 45 tablets of aluminum phosphide per 1,000 cu. ft. applied under polyethylene sheets. No residues were found in any of the exposed foods. From this work a new fumigant for control of insects in food warehouses that does not leave residues has become available for commercial use. (I) Manhattan, Kan.

Conventional insecticides for stored-product insects. Of 55 new compounds evaluated in the laboratory as direct-contact, residual, vapor, and grain protectant treatments, 15 were found promising for further testing. BAY 77488 was outstanding and appears very promising as an all-purpose insecticide for stored-product insect control. In these preliminary tests, it compares favorably with the more effective contact, residual, and grain protective treatments. Applied at 5 p.p.m., BAY 77488 killed all adult rice weevils and confused flour beetles exposed to the treated grain, and no progeny were produced. It is of further interest because of its relative safety, having an LD₅₀ oral toxicity to rats of 8,000 to 10,000 mg./kg. (I) Savannah, Ga.

Food-storage warehouse treatment for control of stored-product insects. The dichlorvos space treatment and vapor dispensing unit developed specifically for preventing insect infestations in food warehouses was tested for an entire season in a subsistence warehouse at the Naval Supply Center, Norfolk, Va. The test showed that (1) dichlorvos vapor was effective in preventing insect infestation of packaged foods under practical conditions in a warehouse, (2) the application can be accomplished with one dispensing unit per 100,000 cu. ft. of space, and (3) application at the recommended rate of 1 1/2 grams of dichlorvos per 1,000 cu. ft. per week resulted in residues of dichlorvos or dichloroacetaldehyde (the degradation product) of less than 1 p.p.m. in the exposed packaged foods during 20 weeks' use. Most of the analyses revealed 0.4 p.p.m. or less, many only a trace, or none. (I) Savannah, Ga.

Persistence of Herbicides in Soil and Effects on Crops. Studies of 3 to 10 years duration with repeated annual applications to permanent plots showed no buildup of herbicides to levels harmful to cotton. However, some treatments of cotton did result in residues toxic to sugarbeets, milo, oats, soybeans, or barley. Characterization of persistence of herbicides in studies such as these is a vital and continuing part of developing effective and safe methods for controlling weeds. These studies confirmed the need for existing restrictions on the use of several herbicides, and pointed out the need for further research, and possibly additional restrictions for some of the herbicides. (I) Shafter, Calif; Phoenix, Ariz; Stoneville, Miss.

Chemical Control of Nematodes. A new laboratory method has been developed for evaluating the systemic activity of chemicals as nematode attractants, and repellants, and as nematocides. Several benzoic acids killed nematodes in plant roots when the chemicals moved systemically from tomato leaves to the roots. (I) Beltsville, Md.

Molecular Structure vs. Herbicidal Activity. An understanding of the relationship between the molecular structure of herbicides and their specific phytotoxicity is of great importance in proposing new herbicides and using present ones intelligently. Nine closely related symmetrical triazines were studied in nutrient culture in controlled environment chambers to determine their basic phytotoxicity on several crops and weeds in the absence of soil. Basic information of this kind is used in determining the climatic, soil, cultural, and plant growth factors involved in organizing effective methods for field use of herbicides. (I) Beltsville, Md.

Agricultural Aircraft Guidance. A radio navigation system was adapted for use in aircraft for guidance purposes on aerial application programs. In addition to promoting greater accuracy of insecticidal deposits and substantial savings in labor, the system provides a permanent record of each flight. (I) Hyattsville, Md.

New Application Methods for Herbicides. A new spray system has been developed which directs herbicide sprays at right angles to and above the crop row into a catching device which returns the portion of spray not applied to weeds to the original spray tank. The method is effective against weeds growing taller than the crop. The relatively low amount of spray deflected to the crop permitted use of chemicals, normally too toxic to soybeans, to be used successfully for control of major weeds in soybeans such as sesbania, pigweed, cocklebur, and others. A method of converting herbicide sprays to a foam state at the point of release was developed also, and appears promising for several purposes. (I) Stoneville, Miss.

Improved Metering of Herbicides in Horticultural Plantings. Accurate metering of herbicides is very difficult for the average homeowner and he therefore seldom uses these valuable tools most successfully. Experiments using loosely knitted cellulose acetate cloth impregnated with herbicides at accurate acre rates to treat soil showed that this method of applying herbicides is practical. Advantages of this method are improved metering; greater convenience in application; elimination of drift hazards; minimizing of exposure to contact with and inhalation of herbicides; and minimizing the possibility of accidental ingestion by humans and animals. The results of these experiments represent a major advance in the development of practical methods of herbicide use for the homeowner. (I) Beltsville, Md.

Postemergence Injection of Herbicides. The activity of several herbicides on problem weeds was increased by placement of the chemical beneath the soil surface in bands and in lines. Tolerance of crops such as cotton, peanuts, soybeans, and sugarbeets varied with spatial relationship between the herbicide and germinated crop seedlings. Injection of vernolate or EPTC on each side of the row controlled nutsedge and Johnsongrass with little damage

to cotton, soybeans, or peanuts. Although most of the research has been with preplanting or preemergence applications, it now appears that research with post-emergence injections may lead to outstanding new concepts in control of weeds. (I) Stoneville, Miss; Tifton, Ga; Prosser, Wash.

Interfering Substances in Analysis for 2,4-D. Gas chromatography serves as a useful tool in the rapid determination of minute quantities of some pesticide residues in crops and soils. The need for using more than one method of analysis is reiterated by research showing that two natural plant pigments of bromegrass and timothy have retention characteristics identical to 2,4-dichlorophenoxyacetic acid (2,4-D) on several types of commonly used chromatographic columns. The plant pigments were identified as the all-trans isomer of lutein and violaxanthin. (I) Ithaca, N. Y.

Simplified pesticide residue analytical methods. Outstanding progress has been made on the development of simple, rapid methods for determining the presence of tolerance-level residues of 10 classes of pesticides in 11 groups of foodstuffs. New extraction techniques were developed using low-hazard solvents. Liquid-liquid partition was used for cleanup of extracts of fatty foodstuffs. Final detection and identification of pesticide utilized thin-layer chromatography. The methods were especially designed for use with an internally powered portable laboratory packed into two suitcases. The laboratory can be operated for 8-hour periods on locations such as harvest fields, rail and ship sidings, terminal elevators, processing plants, etc., for determination within as little as 1 hour whether pesticide residues in excess of tolerance levels are present on raw and processed commodities. (E) Midwest Research Institute.

Removal of Organic Herbicide From Water. Adsorption and translocation studies have shown that diquat is adsorbed to soil, kaolinite, and montmorillonite in amounts similar to paraquat. Only montmorillonite appears to be able to hold these herbicides in an unavailable form to wheat at extremely high rates. When montmorillonite was added to plastic pools, the concentration of paraquat in solution was drastically reduced within 24 hours. (E) Ala. Agr. Exp. Sta.

Washing Removes Pesticide Residues. During the past year, preliminary studies were undertaken for the removal of captan, parathion, and methoxychlor from Hudson cherries, DDT from apples, and endrin from cole crops. In all cases significant reductions in the surface residues could be accomplished without alteration of keeping quality of the produce. The pesticides selected were representative of the various classes of compounds in commercial use. (E) N. Y. State Agr. Exp. Sta., Geneva.

Animals

Promising Anthelmintic for Sheep Nematodes. Three formulations of Maretin (O,O-diethyl-O-(naphthaloximido) phosphate), were tested for effectiveness in the removal of gastrointestinal nematodes from naturally-infected ewes

in Georgia. At a dose level of 50 mg/kg of body weight, all treatments effectively reduced the number of eggs of the Cooperia-Trichostrongylus-Ostertagia group and of Haemonchus spp. produced. There was no evidence of toxicity in any of the treated ewes. (I) Auburn, Ala.

Field Crops

Synthesis and Characterization of Abscisin II. Chemical synthesis of the naturally occurring abscission accelerant extracted from cotton plants (Abscisin II) has furnished material for further evaluations of the substance's effect on growth and developmental processes in plants. Results indicate that Abscisin II plays a role in the regulation of a wide number of plant processes, including bud dormancy, flowering, growth, tuber formation, and the abscission process. (I) Davis, Calif.

New Chemicals for Rust Control. Two new chemicals were evaluated in the greenhouse for effectiveness in controlling wheat rust and loose smut. The tests indicate that there is a potential for control of wheat rusts by seed or soil treatments. The compounds also reduce loose smut. (I) St. Paul, Minn.

Low-Volume Applicator. A low-volume ground sprayer with two interchangeable nozzle systems has been developed for use as a research tool. One nozzle system on the sprayer can spray insecticides at rates of 1 gallon or more per acre. Compressed air forces liquid from the insecticide tank through the nozzles in an operation. The other system can spray insecticides at rates as low as 1 pint or less per acre. Compressed air at low pressure forces liquid from the tank up to the nozzles, where a high-pressure air stream flowing directly from the compressor atomizes and disperses the spray. (I) Tifton, Ga.

Use of Airflow from Treated Grain May Extend Insect Control Without Additional Application of Insecticide. The effectiveness and persistence of a fresh malathion treatment on wheat was not altered by aeration for 5 weeks at conventional airflow rates of 0.05 or 0.1 c.f.m./bu., with the air at 80°F. and 75 percent relative humidity. Air drawn from malathion-treated wheat was highly toxic to rice weevils at first and progressively declined in toxicity during 5 weeks of aeration at conventional airflow rates. Air drawn at a high flow rate remained nearly as toxic to rice weevils after 4 weeks of aeration as it was during the first week. Tests are planned to evaluate use of this toxic air for insect control in grain that has not been treated with malathion and in previously treated grain to determine whether some grain may not have to be treated or whether some retreatments might be eliminated. (I) Manhattan, Kan.

Studies on Pesticide Combinations and Rotations in Rice. The insecticides parathion and dichlorvos did interact with propanil to cause herbicide damage to rice; whereas, the insecticides fenthion and S,S-benzylidene-bis-(O,O-dimethylphosphorothioate) did not. In the absence of insecticides, propanil applied continuously for six years controlled weeds without injury to rice and was as effective as rotating other herbicides with it. Propanil, CIPC, swep, O,S-dimethyl tetrachlorothiophthalate, NPA, amiben, and linuron used continuously and alternately did not damage rice or soybeans grown continuously or alternately. (I) Stuttgart, Ark.

Fungicide Treatment Controls Fairy Ring. Captan 50-W rototilled into soil at 5 pounds per acre was the only pesticide of 5 tested that controlled turf fairy rings for 3 years in plots of centipedegrass. Fore, Manzate-D, Dithane, Z-78, and Panogen inhibited fairy rings for 3 months when applied with surfactants. With the exception of Captan 50-W rototilled into the soil available pesticides appear unsuitable for the homeowner. (I) Tifton, Ga.

Boll Weevil Control. Side-dress applications of Temik to cotton at squaring were effective against overwintered boll weevil adults at Waco, Texas, Stoneville, Miss., and Tallulah, La. At Florence, S. C., in replicated small plot field tests, side-dress applications of Temik were as effective as carbaryl applied conventionally until boll weevil migration. (I) Waco, Tex.; Tallulah, La.; Stoneville, Miss.; and Florence, S.C.

Develop Improved Sucker Control Compounds in Tobacco. The naturally occurring growth regulator, indole-3-acetic acid, was enzymatically oxidized in the presence of horseradish peroxidase, and various cofactors. The oxidation mixture contained three biologically active components. Biological activity of one component was about 300 times greater than IAA alone and another was about equal to IAA. These results indicate the enzymatic transformation of IAA to peroxidase enzymes is a part of the amplification mechanism for IAA in plants. This new information may provide a key to tobacco sucker control through the use of natural growth regulators. (I) Tifton, Ga.

Horticultural Crops

Growth Regulators to Control Regular Bearing in Apples and Cherries. Three years' results with Alar (N-dimethyl amino succinamic acid) show that this growth retardant consistently reduces shoot growth when the chemical is applied at the rate of 1000 ppm 10-14 days after bloom. This application also reduces watercore, prolongs the storage life of the fruit and causes heavier return bloom in the spring. With C¹⁴ labeled Alar, it was found that when applied as a foliar spray, Alar breaks down very slowly and very few other compounds are labeled from its breakdown sequence. (I) Wenatchee, Wash.

Control of Peach Bacterial Spot. In field tests under relatively severe disease conditions, oxytetracycline (Terramycin) antibiotic satisfactorily controlled bacterial spot (Xanthomonas pruni) on Rio-Oso-Gem peach without injury. Addition of the biologically inactive solvent dimethyl sulfoxide (DMSO) significantly enhanced the effectiveness of the antibiotic. Fruit at harvest time had no detectable antibiotic or off-flavor after seven spray applications. (I) Beltsville, Md.

Malathion-treated Drying Trays Prevent Insects in Raisins. Studies in previous years have shown the effectiveness of a malathion treatment on trays on which grapes are dried for protecting the grapes and raisins against insect infestation during drying and subsequent storage. Studies on the 1965 crop to determine what factors affected pickup of malathion

by the raisins indicated that dry ratio, sugar content, and average daily temperature were the most significant of 11 factors evaluated. The individual importance of each is not yet known. The field studies showed that a treatment on the trays of 100 mg. per sq. ft., rather than 200 mg. as used previously, would put an adequate protective deposit into the raisins and would not exceed the Food and Drug tolerance of 8 p.p.m. About 10,000,000 malathion-treated trays will be used commercially on the 1966 crop. This development provides the growers with an effective and efficient insect control procedure that does not require him to apply insecticide and assures the processor that the commodity will not contain a pesticide residue that exceeds the tolerance established by FDA. (I) Fresno, Calif.

Chemical Control of Pecan Scab. Under ideal natural conditions for infection, a new fungicide DuTer (tri-phenyl tin hydroxide) promises to be the most effective chemical to control pecan scab. (I) Albany, Ga.

Forests

Promising replacement for DDT in Forest spraying. Adverse side effects have limited the usefulness of chlorinated hydrocarbon insecticides for use in forest spraying. For example, serious spruce budworm infestations have been left untreated because of the lack of a proven insecticide that could be substituted for DDT. Carbamate and pyrethroid insecticides generally are non-persistent yet are highly toxic to some forest pests. Zectran, one of the carbamates, was found to be highly effective against the spruce budworm at very low dosages providing it is properly distributed. These studies move us one step forward toward the goal of having available insecticides that will affect only the target organisms, and will provide materials that minimize some of the adverse side effects experienced with DDT and other persistent insecticides. (I) Berkeley, Calif.

Protecting hardwoods from insect damage. The sapwood of valuable hardwood lumber is highly susceptible to attacks by lyctus powder-post beetles. In a recent study it was found that a chemical treatment applied by passing green lumber through a dipping vat for 10 seconds immediately after it is sawed will protect it from lyctus beetles. A treatment in which 0.1% benzene hexachloride (BHC) is added to stain preventive dip solutions has for some time been recommended for prevention of ambrosia beetles during the drying period. To make the ambrosia beetle treating solution effective for lyctus beetles also, the strength of BHC in a solution needs to be increased only 0.25%. Thus two important economic insect pests and a stain producing organism can be controlled in the mill with a single operation. (I) Gulfport, Miss.

Additional information may be found on page A-41.

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TARGET IV

TO STUDY THE TOXICITY, PATHOLOGY AND METABOLISM OF PESTICIDES
AND INVESTIGATE LEVELS, EFFECT, AND FATE OF THEIR RESIDUES
IN PLANTS, ANIMALS AND THEIR PRODUCTS, AND IN THE
ENVIRONMENT

General

Synthesis of Radio-labeled Pesticides. One of the more significant deterrents to metabolic fate research is the lack of availability of suitably-labeled pesticides. In many cases, the radioactive pesticide labeled in the position that would provide the most critical information is not available commercially. Propanil C^{14} -labeled in 2 positions in the alkyl side-chain have been synthesized, and C^{14} -ring labeled propanil is currently being synthesized. Ring labeled monuron- C^{14} and diuron- C^{14} are being synthesized in order to refine studies on their metabolism. (I) Fargo, N. D.

Movement of Pesticides in Soils. A soil column system for evaluating the relative movement of pesticides has been developed. By this method, it is possible to predict the movement of new pesticides in the field relative to the movement of older more widely used pesticides. Studies on the vertical movement of insecticides and herbicides in soils showed that the chlorinated hydrocarbon insecticides (dieldrin, endrin, aldrin, and DDT) tend to remain in the upper soil layers. In contrast the benzoic acid type herbicides (Tricamba, 2,3,6-TBA, dicamba, amiben, and fenac) move to much deeper depths in soils and may ultimately pose some threat as a pollutant to our ground water supplies. (I) Beltsville, Md.

Predicting Pesticide Persistence in Soils. The persistence of a large number of organic herbicides of different chemical composition have been studied in soils, in soil microorganism culture solutions, and in enzyme solutions in an effort to determine what electronic and structural features of a molecule make it biodegradable. Substitution of different groups at the meta position of the phenylcarbamate herbicides has an effect on the rate of breakdown. The size of the alcohol group also affects the rate of breakdown. The larger the alcohol, the slower the rate of detoxification. From these studies, scientists may be able to predict the longevity of a compound in soils. (I) Beltsville, Md.

Long Term Persistence of Dieldrin, Endrin, and Heptachlor in Soils. The persistence of several chlorinated hydrocarbon insecticides in soil is being determined. The insecticides were thoroughly mixed in soils which were placed in cold frames containing tile and gravel drainage. Dieldrin, endrin, and heptachlor were applied to one soil. (Analysis has been made by electron capture gas chromatography.) The average percentages remaining after 15 years were: endrin, 33 percent; dieldrin, 40 percent; and heptachlor, 17 percent. The concentration of endrin, dieldrin and heptachlor varied with depth. There was less dieldrin in the 6-12" layer than in the 0-6" layer while the opposite was true for heptachlor and endrin. The loss of endrin and dieldrin was not affected by the rate of application while the percent of heptachlor remaining at an application of 200 lb/A was five times that remaining at a 100 lb/A application. (I) Beltsville, Md.

Mechanism of Action of Amitrole. Amitrole inhibits one specific enzyme required in the biosynthesis of an amino acid (histidine) essential for protein formation. The enzyme from both photosynthetic and non-photosynthetic plants shows the same very high sensitivity to the herbicide. Growth of non-photosynthetic plants is controlled by this inhibition. However, growth of green plants is primarily affected through another, more sensitive and as yet unidentified site of action (possibly a site involved in one carbon metabolism) which is either non-existent or less sensitive in non-photosynthetic plants. (E) Warsaw, Poland (PL 480), (I) Beltsville, Md; Stoneville, Miss.

Monuron Degradation. Studies have shown that there is a close correlation between the loss of inhibition of photosynthesis by monuron and the rate and extent of degradation of monuron. Using a leaf disc technique, it was shown that the measurement of photosynthetic gas exchange by the leaf tissue gave an indirect indication of the loss of monuron in the tissue. This technique promises to give a rapid and sensitive measure of the fate of a number of photosynthesis inhibitors in plants. (I) Fargo, N. D.

Effect of s-Triazine and Phenylurea Herbicides on Soil Fungi in Corn and Soybean Cropped Soils. Atrazine, simazine, linuron and diuron exert significant quantitative and qualitative effects on soil fungus populations. The effects exerted vary with the chemical applied, application rate, and crop. Numbers of Fusaria in atrazine treated soils were significantly lower than in simazine treated soils. Phenylurea herbicides decreased total numbers of Fusaria in soybean cropped soil, but had no effect on Fusaria in corn cropped soils. All four chemicals stimulated one or more genera of fungi known to be antagonistic to Fusaria. Since certain Fusaria are root rotting organisms, use of these chemicals may prove beneficial not only in weed control but as a means of controlling certain soil-borne plant pathogens via their effect on antagonists. (I) Beltsville, Md.

Detoxification of Simazine and Atrazine in Soils. The s-triazine herbicides are widely used for weed control in corn. Under certain conditions harmful residues may persist in soils for successive crops. Two pathways for the degradation of the s-triazines have been described in soils. The major

route of detoxification is a chemical reaction that forms the hydroxy analogs of simazine and atrazine. High temperatures speed up the rate of conversion to the nonphytotoxic products. A second series of reactions is carried out by a soil fungi to yield the dealkylated products of simazine and atrazine. One of the products of atrazine metabolism, 2-chloro-4-amino-6-isopropylamino-s-triazine is phytotoxic. The appearance of some phytotoxic metabolites by some soil microorganisms may account for the longer persistence of some s-triazine herbicides. (I) Beltsville, Md.

Analytical Procedure for 2,4,5-T. The analytical procedure for 2,4,5-T and 2,4,5-T propylene glycol butyl ether ester was revised, the metabolism of these compounds in skeletal muscle tissue was worked out, and the absorption and excretion in sheep detected and measured in blood and urine specimens after exposure. (I) Kerrville, Tex.

DDT residues in streamwater - after forest spraying. No significant amount of DDT was found in streamwater before or after spraying to control the Douglas-fir tussock moth. Water was sampled periodically from the main drainage of a large area that had been sprayed with DDT at the rate of 3/4 pound per acre. However, cooperators from the Oregon State University Department of Fisheries and Wildlife found traces of DDT or some of its isomers in animal life even before spraying was done, and these amounts increased after spraying. The highest DDT residue--1.2 parts per million--was found in trout while the lowest was 0.002 part per million in herbivores. Sampling will be continued indefinitely to assess the long-term effect of spraying. (I) Corvallis, Ore.

Animal

Oxime Compounds as Antidotes. The effects of oxime compounds as specific antidotes for organophosphorus poisoning was studied. On oxime blood levels, the slower the recession, the greater the peak concentration and overall effectiveness as an antidote. Of those compounds studied, TMB₄, 2-PAM-Cl and P2S would thus be rated as to their effectiveness in cattle, at either the 25.0 or 37.5 mg./kg. levels of dosing. (I) Kerrville, Tex.

Toxic Doses of Herbicides. Screening to determine the minimum toxic dosages, the signs of toxicosis, and the gross pathological lesions was completed for 29 herbicidal compounds to chickens, sheep and cattle. (I) Kerrville, Tex.

Herbicidal Treatment of Veratrum. The toxic and teratogenic effects of Veratrum californicum on cattle and sheep were not affected by herbicidal treatment of 2,4D, 2,4,5T and 2,4,5T-P (Silvex). (I) Logan, Utah.

Forage from Lead-contaminated Soil not Toxic to Animals. Bromegrass plants grown on soils contaminated with lead (680 ppm) from a nearby battery smelter in Minnesota did not accumulate sufficient quantities of lead to be toxic to animals. It is reported that at least 150 ppm lead in the total ration is

needed to be toxic, and the greatest concentration accumulated in the forage was only 12 ppm. (I) St. Paul, Minn.

Locations for Estimating DDT Residues in Cattle. DDT residue concentration in caudal fat approximates the average concentration among individual muscle and fat tissue locations. This finding is important to the monitoring of residues in livestock and indicates that taking samples from the tail can replace the more laborious and expensive method of taking samples from the abdominal cavity. Muscle tissues contained considerably less residue than fat tissues. However, the residue concentration varied considerably among the several locations for both muscle and fat tissue. At all locations, peaks of residue concentration in cattle receiving large doses of DDT for a short period were higher than in cattle receiving small doses for a longer period. The residues were also eliminated more rapidly in the cattle receiving the larger doses. (I) Beltsville, Md.

Storage of Insecticides in Animal Tissue - DDT vs Dieldrin. The storage of dieldrin in the adipose tissue of animals was markedly depressed when DDT and dieldrin were fed simultaneously. DDT, added to the diet at 50 ppm. cut dieldrin storage to about 10 percent of that in animals not given DDT. Methoxychlor neither influenced the storage of DDT or dieldrin nor was influenced by either of them. Nine drugs were tested and each caused a significant reduction in dieldrin storage but none was as potent as DDT in this respect. Other chemicals, however, might be as potent as DDT or more so in their ability to influence the storage of chlorinated hydrocarbon pesticides but with the advantage of being less objectionable. (E) Utah Agr. Exp. Sta.

Bromophos Residues in Sheep. The Bromophos residues in the omental fat of sheep dipped repeatedly was determined by gas chromatography after extraction and clean-up procedures were established. (I) Kerrville, Tex.

Field Crops

Metabolism of Propanil in Rice. Rice is known to metabolize propanil to nonphytotoxic products, but the identity of these metabolites has not been clarified. Current studies show that the propionic acid moiety may be lost from the molecule, and that a chloro-aniline-containing metabolite is complexed with natural macromolecules to form at least three as yet unidentified products. (I) Fargo, N. D.

Forests

Long Range Study of Timber Beetle Population. A long time study of the Columbian timber beetle has been underway. An intensive examination through two epiphytotics of population development in time and space,

has revealed discreet "epicenters" within a stand which expand and contract over a several year period. Finally, an indigenous population has been defined and followed. Evidence becomes clear that the population in the experimental stand which originated 25 years ago, has resulted in two major explosions and already demonstrates a dampening oscillation action. The relationship between time of attack to stain development, sap wood growth, and callus tissue plugging has been studied. The differences, between seasons, in tree physiology reflected by these phenomena, may have a profound influence on beetle behavior. (E) Ind. Agr. Exp. Sta.

Additional information may be found on page A- 58.

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TARGET V

TO STUDY ECONOMIC ASPECTS OF PEST CONTROL; SURVEY PESTICIDE USE;
DETERMINE THE SUPPLY AND REQUIREMENTS FOR PESTICIDES; AND GIVE
ASSISTANCE TO CONTROL AGENCIES AND INDUSTRIES IN EMERGENCIES

Economic Analysis of Water Pollution by Pesticides and Other Agricultural Wastes. Research has been initiated in cooperation with Iowa State University. This research is considering residue and waste problems using a watershed case study. A part of this program is to develop a general framework of analysis and an analytical model for considering these water quality problems in a watershed or riverbasin context. (I and E) Ames, Iowa.

Economic Value of Pest Control. Ranchers interviewed and plots laid out to determine the value of brush control on range land. Information gained from these interviews indicated that aerial spraying of mesquite returns an average of about 25 percent on investment annually. Tobacco growers were contacted periodically throughout the 1965 season and data were obtained on the economic effect of insect control measures on the market value of tobacco. Data on quantity, quality, price and warehouse sales tickets were obtained and will be analyzed and published. Only one herbicide of three tested showed less cost than hoeing for weed control in a plot of yew trees in a nursery during a very dry season. Managers of elevators were interviewed on fumigants used. They reported the cost was nominal and varies with length of storage period and weather. Greatest problems were associated with receipt of infested grain. (E) Ky., Miss., S. C., and Tex. Agr. Exp. Stas.

Consumer Attitudes Toward the Use of Pesticides in Producing Food. Questionnaires were developed, prepared, pretested, revised and worked into final forms for surveys of consumers' attitudes toward the use of pesticides in the production of food products. The final questionnaires included information concerning the characteristics of the households interviewed, the acceptance of pesticides by these households, and the demand of these households for agricultural products treated with pesticides. Low income

housing, suburban middle income and rural farm areas were surveyed. Many interviews have been completed and the data will be summarized and published. (E) Conn., (Storrs), Ill., and Pa. Agr. Exp. Stas.

Survey of Pesticide Use in Agricultural Production. Preliminary estimates from the nationwide survey of pesticide uses show that in 1964, 94 percent of all farmers surveyed used chemicals for controlling pests of crops or livestock. Nearly three-fourths of the farmers used pesticides on crops compared with about two-thirds that treated livestock. About 90 percent of the dairy farmers and 75 percent of the other livestock farmers treated livestock. Farmers' expenditures for pesticides in the United States for 1964 were around \$480 million. Of the total expenditures, about 85 percent was for the treatment of crop pests, growth regulators, and harvesting aids. These estimates do not include expenditures for seed treatment or treating stored crops and storage buildings. The second nationwide survey of pesticide use is planned for early 1967. (I) Washington, D. C.

Communications Pattern Among Farmers on Pesticide Use. Farmers were interviewed in two groups. Group one was among the first to use a new pesticide combination and group two was farmers that had discussed the use of this pesticide with farmers in group one. The data were gathered to study the movement of information as related to attitudes, knowledge, and behavior. The results indicate that farmers who are committed users of pesticides, scored about 50 percent on technical terminology; technical information tended to be obtained from research organizations and industry, not traditional adult education channels; farmers show some concern over dangers of the pesticides, primarily those directly affiliated with the farmer and his operation; and farmers show some willingness to accept external controls over the use of pesticides. (E) Wis. Agr. Exp. Sta.

Pre-emergency and Emergency Operations Relating to Production of Crops and Livestock. The Department assembles such data as can be gathered which relate to production capacity, supply and usage level of pesticides. This information is used in estimating requirements under current conditions and for various levels of emergency mobilization. The staff involved collaborates with chemical units such as those in the Department of Commerce, Department of the Interior and Tariff Commission, working to obtain as complete and useful statistics as feasible. The Business and Defense Services Administration and the Bureau of International Commerce are assisted, upon request, in their consideration respectively of shortages of materials and of shipments of goods under export control. (I) Washington, D.C.

Consumption. Domestic disappearance at the manufacturers' level can be calculated for only a few chemicals because so many pesticides are proprietaries.

The Census of Agriculture for 1964 for the first time included pesticide data; however, these were limited to acreage figures with some crop breakdown. The total acreage reported treated for insect and disease control was 39,352,000 acres and that for weed control was 64,501,000 acres.

Most states (22 of them) with large acreages of fruits, vegetables, cotton and tobacco treated more acres for insect and disease control than for weeds. Texas led in insect and disease control (3.7 million acres) with California close behind (3.5 million acres). North Dakota showed the largest number of acres (6.9 million) under weed control.

Estimated total cost of pesticide preparations to all U. S. users in 1965 was over a billion dollars. Farmers used pesticides costing an estimated \$590 million, 58 percent of the total. Residential (home, lawn and garden) purchases amounted to about \$200 million, or 20 percent of the total cost and industrial, institutional, and governmental purchases the remaining \$220 million or 22 percent. The tonnage used by the farmer is greater than 58 percent of the total weight consumed because of his bulk purchases in contrast to the small-package residential trade with its much higher unit cost. (I) Washington, D. C.

DDT. Consumption in the United States has declined gradually from the high crop year 1958-59. Production in the first nine months of calendar 1966 amounted to 108.8 million pounds, two percent less than in the same period of a year ago. Exports in the first nine months were 74.8 million pounds of which 36.8 million were shipped as 75 percent formulation. Large quantities were shipped for use in malaria eradication in India, Pakistan and Thailand. (I) Washington, D. C.

Organophosphorus insecticides. U. S. production of organophosphorus insecticides in 1965 was 95,561,000 pounds, up 18 percent from 1964, and estimated use in the United States is 65 million pounds. Seventeen percent of the 1965 production was parathion and 30 percent methyl parathion, with most of the remainder proprietary compounds. Exports of technical organophosphates in 1965 amounted to 29 million pounds of which 46 percent went to Mexico, Guatemala, El Salvador and Nicaragua. Central America is a particularly active U. S. market where at least one U. S. firm has located parathion formulating facilities to serve cotton growers. All U. S. firms making the parathions have expanded their production facilities or have expansions under construction, but the growth rate for these insecticides abroad has outstripped even that achieved in the United States. Production of methyl parathion in 1966 through September amounted to 37,060,000 pounds, compared to 29,111,000 pounds total for the 1965 year. (I) Washington, D. C.

Chlorinated hydrocarbons. Aldrin, chlordane, dieldrin, endrin, heptachlor and toxaphene as a group are used extensively against many insect pests in a variety of situations. U. S. consumption, amounting to 34 million pounds in 1953, rose steadily to a level of about 80 million pounds a year since 1961. Production ranged from 104 to 106 million pounds between 1961 and 1964, but increased to 119 million in 1965. Exports of these and other "polychlor" insecticides rose sharply last year. (I) Washington, D. C.

Herbicides. Herbicide production and sales soared in 1965 and 1966 to meet heavy demand for weed control. Soybean acreage up seven percent and

rice up nine percent offset a 28 percent cut in 1966 cotton acreage down to 9.8 million acres. Most herbicides used on these crops are pre-emergence, hence application time is short, even shorter if rains interfere with field work at planting time. Consumption on an unexpectedly large soybean acreage together with the short buying season resulted in supplies of some popular materials being completely sold out. Generally the volume of herbicide usage is in proportion to acreage and but little affected by weather, although the proportion of treated crops increases gradually year by year.

The 1967 wheat allotment of 68.1 million acres is 38.9 percent above the August 1 estimate of acreage to be harvested in 1966. This additional wheat acreage may be treated for weed control in nearly the same proportion (about 25 percent) as this year. (I) Washington, D. C.

Basic Data for Emergency Planning. The 1966 Pesticide Review was printed in October and distributed to interested government agencies (Federal and State), and industrial and related organizations and individuals. This report formerly known as The Pesticide Situation has been published annually since 1953. The primary objective is to assemble information needed in planning for a national emergency. The report contains available data, both general and specific, on production, foreign trade and domestic consumption. The data are derived from publications and by direct contact with Federal and State collecting agencies, non-government market research organizations and individuals, the chemical industry and trade journals. The information forms the basis for estimating pesticide requirements. The report is in much demand by government agencies concerned with chemicals, the chemical industry generally, and many engineering firms, advertising agencies, financial institutions, trade journals, and consultants. Numerous requests for it are received from abroad.

Exports to Viet-Nam have ranged in recent years from a value of \$500,000 to \$1,000,000 annually. These figures do not include military shipments. The pesticide exported to that country in the largest quantity in 1965 was 75 percent DDT, equivalent to 1,773,000 pounds actual DDT. This was appreciably less DDT, however, than was shipped to Viet-Nam any year recently.

Not only have large quantities of DDT been employed in ridding India of malaria but increasingly large quantities of U. S. agricultural insecticides have been shipped there. This accords with India's indicated desire that its 425 million acres of cropland be protected with pesticides by 1971. (I) Washington, D. C.

Additional information may be found on page A-68.

TARGET VI

TO CONTROL PESTS

Detection of Foreign Plant Pests. The cooperative national insect detection network reported the discovery of eight species new to the United States in fiscal year 1966. A total of 105 new State records, involving established species still spreading in the country, was also reported. One of the most important new records involved the Formosan subterranean termite. This serious Asian pest of structures and other wood products was found at Houston and Galveston, Texas, and at New Orleans and Lake Charles, Louisiana. Detection surveys were expanded to other areas to provide information for further action against the pest. Detection of foreign pests around ports of entry was strengthened during the year by expanding trapping operations. (I and E) Nationwide.

Fruit Fly Detection Program. Detection surveys for the Mediterranean and other important foreign fruit flies were continued in the citrus area of the United States and Mexico. Over 32,000 sex-lure traps were used in the network. (I and E) Tex., Fla., La., Ariz., Miss., Mexico.

Mediterranean Fruit Fly Infestation. Prompt detection of a Mediterranean fruit fly infestation in Brownsville, Texas, late in fiscal year 1966, was an important factor in the subsequent successful eradication effort involving the use of a chemical pesticide. The eradication program was initiated during the closing days of fiscal year 1966 in cooperation with Republic of Mexico. Within 44 days this pest, which could have invaded citrus and vegetable growing areas of the United States, had been eliminated. An improved low volume formulation of 2.4 fluid ounces of technical malathion and 9.6 ounces of sauce bait per acre was used. If this pest became widespread, growers would be required to apply multiple applications of insecticides throughout the growing season to provide "worm-free" produce. (I and E) Texas, Mexico.

Cereal Leaf Beetle. The cereal leaf beetle, a serious introduced pest of small grains, was first found in the U. S. in Michigan in 1962. Intense detection surveys have revealed presence of the beetle in wide areas of Michigan, Indiana, and Ohio, and three counties of Illinois. Stringent quarantine regulations of movement of articles capable of spreading the cereal leaf beetle coupled with aerial sprays with low volume malathion have thus far prevented the westward spread of the pest into the principal small grain producing areas of this country. During fiscal year 1966, a total of 1,627,047 acres was treated. Due to the gradual natural spread of the pest and the increasing need for large-scale insecticide applications to control it, actions have been taken to explore supplemental control techniques. (I and E) Mich., Ind., Ill., Ohio.

Khapra Beetle. The khapra beetle, one of the most damaging pests of stored products, is a continuing threat to grain, seed, and feed production. Continued detection surveys revealed a new infestation near Brawley, California, in March 1966; the first in California since the pest was eradicated from the State in early 1962. About 2.5 million cubic feet of storage building and feed lot in this latest outbreak were fumigated. Infestations have been found and eradicated in more than 800 sites in Arizona, California, New Mexico, Texas, and the Republic of Mexico, since the pest was first found in California in 1953. At the close of the year no nontreated infestations were known to occur in the United States or Mexico. Prompt detection and treatment of infestations since 1953 have prevented spread of the pest over wide areas of the United States; thus precluding extensive treatments of grain storage sites. (I and E) Southwestern States, Mexico.

Grasshopper Control. Cooperative grasshopper control programs, supported by Federal, State, and private interests, have provided valuable protection of crops and rangelands. Incipient outbreaks are detected and treated, thereby eliminating the need for large-scale control programs in areas remote from the target infestations into which the pests may migrate. Heavy populations built up in the spring of 1966 in several Western States. Controls were applied on 1,491,202 acres. Low volume malathion was applied by aircraft at the rate of eight ounces per acre. (I and E) Idaho, Mont., N. Mex., Ore., Tex., Utah, Wyo.

Boll Weevil Control Program in Western States. Boll weevil is the major pest of cotton in the United States from Texas eastward. A control program in the Texas High Plains and the Big Bend area is underway to protect the immediate area and cotton States to the west. These treatments have minimized the threat of spread of the boll weevil into Arizona, California, and New Mexico where 25 percent of the nation's cotton crop is grown. This action has precluded the need for growers in these States to use large volumes of pesticides for yearly boll weevil control. A total of 1,637,385 aggregate acres of infested cotton was treated in fiscal year 1966 in the High Plains area of Texas and in northwest Mexico in the containment effort. (I and E) Western States, Mexico.

Mormon Cricket. The advantage of treating incipient outbreaks of Mormon crickets before they band and migrate to damage crops and rangeland has been demonstrated. These timely treatments have eliminated economic damage in recent years. Less than 4,000 acres required control measures during fiscal year 1966, whereas in 1941, chemical bait had to be applied to more than 550,000 acres of infested grassland and cultivated cropland. (I and E) Western States.

Witchweed. Witchweed, a parasitic plant which attacks roots of corn, sorghum, sugarcane and other grasses, was discovered in North Carolina and South Carolina in 1956. Eradicative herbicidal treatments have shown that the pest can be prevented from spreading. If this weed were to spread to principal corn, sorghum, and sugarcane areas, more than 81 million acres of these crops would be susceptible to infestation. To successfully produce crops in the invaded areas, multiple applications of herbicides would be required. Over 522,000 aggregate acres were treated with 2,4-D in infested cropland during the year. (I and E) N. C., S. C.

Golden Nematode Eradication Program. Progress continued on eradication of the golden nematode of potato on Long Island, New York, the only known infested area of the country. All known infested potato fields had been treated by the summer of 1965. The development of a resistant potato variety plus the chemical treatment program increases the possibility of eliminating this serious pest from the United States. Nearly 119,000 acres were surveyed for the nematode in noninfested areas during the year. (I and E) N. Y., Calif., Idaho, Maine, Mass., Mont., N. J., N. M., Ore., R. I., and Wash.

Gypsy Moth Bait Trap Dispersal Equipment. Saturation of infested areas with sex-lure baited traps is being studied as a male annihilation technique. A device for dispersing the traps by aircraft for male moth population suppression purposes has been developed. (I) Md., N. J., N. Y.

Gypsy Moth Parasites and Predators. Approximately 9,650,000 gypsy moth parasites and predators were reared and released during 1965-66. The various species were released in saturation numbers primarily along the periphery of the generally infested area in New Jersey, New York, and Pennsylvania. (I) Northeastern States.

Mexican Fruit Fly - sterile releases. The release of sterile Mexican fruit flies in northwest Mexico continues to provide protection to the California and Arizona citrus industry. Over 2-1/4 million flies were released from May-November, 1965. The number of wild flies trapped during this period was only one-half that of a similar period when pesticides were used. A new rearing-radiation facility has been established at Monterrey, Mexico, to support this activity. (I) Ariz., Calif., Mexico.

Preventing the Entry of Plant Pests. For quarantine purposes 202,802 planes, 63,950 ships, 32,022,014 motor vehicles (from Mexico), 1,101 coaches and pullmans (from Mexico), 49,610,799 foreign mail parcels,

302,144 shipments moving interstate, and 99,887 cargo entries under permit were examined. In addition, 42,293,434 pieces of incoming baggage were inspected and the cleaning or treatment of 4,204,104 pieces of cargo was supervised. In performing these activities, 23,849 plant pests were intercepted that would have otherwise entered the country. (I and E) Nationwide.

Pest Interceptions at Ports of Entry. Among the major plant pests intercepted in fiscal year 1966 were: Mediterranean fruit fly 134, oriental fruit fly 37, cherry fruit fly 105, melon fly 7, the olive fly 48, pink bollworm 121, khapra beetle 486, citrus canker 499, sweet orange scab 381, citrus black spot 614, golden nematode 84, and the Mediterranean land snail 201. Preventing the entry and establishment of these and other plant pests has materially aided in minimizing the use of pesticides since most of them would bring about the use of insecticides or fungicides should they gain a foothold in the U. S. (I) Nationwide.

Pesticides Drift. Cooperative studies were initiated to evaluate hazards associated with drift created as a result of aerial applications of pesticides. By means of equipment modification, improved application techniques and formulation development, efforts are being made to reduce drift and residue problems. (I) Hyattsville, Md.

Pink Bollworm Rearing. A pilot plant mass-rearing facility has been established to insure an adequate supply of sex attractant for detection purposes and to support sex attractant and sterilization research studies. Light traps, which are more costly and not as effective, were formerly used for pink bollworm detection. (I) Brownsville, Texas.

Cereal Leaf Beetle Parasites. Rearing of the cereal leaf beetle and its major introduced parasites has been initiated to prepare for extensive colonization and mass releases. Parasites which attack all stages of the host are being considered. Emphasis is being placed on suppression of low populations of the cereal leaf beetle in peripheral areas to prevent spread. (I) Niles, Michigan.

Agricultural Aircraft Guidance. A new radio navigation system was adapted for use in aircraft for guidance purposes on aerial application programs. In addition to promoting greater accuracy of insecticidal deposits and substantial savings in labor, the system provides a permanent record of each flight. (I) La.

Additional information may be found on page A-71.

TARGET VII

TO MONITOR THE PRESENCE AND DISTRIBUTION OF PESTICIDES IN PLANTS ANIMALS AND THEIR PRODUCTS, AND IN THE ENVIRONMENT

Monitoring of Large-Scale Control Programs. Monitoring studies were continued and reports issued on the boll weevil program on the Texas High Plains and the gypsy moth program in Pennsylvania. Similar monitoring studies were continued for grasshopper control in Wyoming, burrowing nematode in Florida, and Witchweed in North Carolina. (I and E) Tex., Pa., Wyo., Fla., N. C.

Monitoring the Effects of Agricultural Pesticides on the Environment. Studies were continued on six one-square mile areas to determine the rate of accumulation or depletion of residues in various components of the environment, including soils, water in agricultural environment, sediment, crops, livestock, and certain species of aquatic and land animals. In addition, special attention was given to the effect of pesticides on non-target insects, including honey bees and other beneficial species. A report of preliminary results was prepared. (I) Miss., Ala., N. Dak., Minn., Ariz.

Soil Monitoring. A pilot soil monitoring program was established to determine existing pesticide residue levels in selected areas of the United States. Seventeen sites were established in high pesticide use areas. Seven of these were in the same areas where the U. S. Public Health Service is conducting Community Studies. Seventeen sites were also established in low use areas such as range and forest lands and 18 sites were located in areas where no pesticides were reported to have been used such as certain Forest Service lands and Wildlife Refuges. Data from this program indicate that contamination of the soil by pesticides is not universal. It has shown that residues do persist in a relatively small acreage of cropland over the United States with particular use patterns. (I) Nationwide.

Monitoring program for meat. Domestic and imported meat is monitored for pesticide residues. Random samples (total of 3,291 samples) indicated that 1.3 percent of domestic meat and 0.5 percent of imported meat contained illegal residues. Analysis of suspected meat (total of 426 samples) revealed illegal residues in 30.0 percent of domestic and 15.0 percent of imported meat. These samples were taken where there was reason to suspect misuse or contamination of food crops. Samples of poultry fat and egg yolk have also been examined. Arsenic determinations were made on 701 samples of domestic meat and 181 samples of poultry livers. (I) Nationwide.

Additional information may be found on page A-78.

TARGET VIII

TO ADMINISTER THE REGULATORY STATUTE--THE FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT--TO ASSURE PROPERLY LABELED PESTICIDES, WITH GUIDELINES FOR THEIR SAFE AND EFFECTIVE USE, AND TO PREVENT THE MARKETING OF HARMFUL, ADULTERATED, OR MISBRANDED PRODUCTS

Registration of Economic Poisons. The Act regulates the marketing of insecticides; fungicides; rodenticides; herbicides; nematocides; disinfectants, and sanitizers; poisons and repellents for pest birds, mammals, reptiles, amphibians and invertebrate animals; plant regulators, defoliants and desiccants. Such products are required to be registered with the Department prior to interstate shipment. Registration is based on labeling and data supplied by the applicant. Evidence must be submitted to show that the product will be safe and effective when used as directed. In 1966, 5,252 new products were registered, an increase of 32 percent over the previous year. Amended labeling involving new uses and directions, stronger precautionary labeling or other revisions was accepted for 9,499 previously registered products, an increase of 17 percent over the previous year. (I) Washington, D. C.

Product Surveillance. Products are inspected at the consumer level to determine whether they are registered, and labeled as represented at the time of registration. During the past year, 3,498 samples were collected as compared to 2,231 of the previous year. Actions, including chemical analysis, biological testing, label review and case proceedings were completed on 2,751 samples. Of this number, 750 were found to be in violation, 562 being major violations. (I) Washington, D. C.

Joint USDA-HEW Statement on "Zero Tolerance" - "No-Residue Registrations. The findings of a committee appointed by the National Academy of Sciences, to evaluate the concept of registering pesticides on a "Zero Tolerance" or "No-Residue" basis resulted in the no-residue concept being abandoned.

Where a safe low-level tolerance cannot be established, zero tolerances will be set. The Department of Agriculture will not register a pesticide for use in a manner reasonably expected to leave residues in or on food in the absence of a finite tolerance. The Food and Drug Administration will establish the necessary tolerances on the basis of data in petitions submitted by proponents of the use. (I) Washington, D. C.

Additional information may be found on page A-79.

TARGET IX

TO EDUCATE AND INFORM THE PUBLIC ABOUT THE IMPORTANCE OF PESTICIDES AND PEST CONTROL, AND THE NEED FOR SAFE AND PROPER USE OF PESTICIDES; MAINTAIN A PESTICIDES INFORMATION CENTER; COORDINATE AND REVIEW PESTICIDE AND PESTICIDE-RELATED ACTIVITIES OF THE U. S. DEPARTMENT OF AGRICULTURE AND COORDINATE THEM WITH OTHER FEDERAL, STATE AND PRIVATE ORGANIZATIONS

Television Spot Announcements. Two sets of pesticide safety spot announcements were filmed and distributed to 550 commercial television stations for public service use. The first set consisted of four cartoon-type announcements, while the second set of seven featured the well-known television puppets, Kukla and Ollie, and were the first such spots to be filmed in color. The announcements have been screened on national network television, and have been shown frequently across the Nation. The Cooperative Extension Service is making use of these spots in programs for State and local groups. The spots emphasize the importance of pesticides as well as the need for safety. (I) Washington, D. C.

Radio Spot Announcements. "Celebrity" pesticides safety radio announcements were recorded by entertainers Arthur Godfrey, Eva Gabor, and Eddie Albert. These spots were distributed to more than 4,500 radio stations, and also to State Extension broadcasters. They have been heard widely. Pesticide value and safe use are twin themes of these public service announcements. (I) Washington, D. C.

Motion Pictures. "Pests or Plenty?" a 13-minute, consumer-oriented color film on the role of pest control in protecting our abundant, quality food supply, was seen by an estimated 4-1/2 million people in the year ending June 30. This included more than 100 television showings and 1,265 screenings before live audiences. The film was an award winner at the Fourth International Agricultural Film Competition in Berlin. A 28-minute movie stressing the importance of modern pest control technology in relation to expanding domestic and world food needs is now in production.

"Operation Spray Safe," a 12-1/2 -minute documentary color movie of forest spraying to control tussock moth near Burns, Oregon, was prepared in 1966. It points up the safeguards built into forest spraying operations and the monitoring carried out by Federal and State agencies and other cooperators to minimize side effects. Prints have been supplied to television stations and for showings before conservation and civic groups surrounding national forests. (I) Washington, D. C.

Newspaper Cartoon Series. A series of cartoons offering tips on safe use of pesticides to the general public is being distributed to approximately 750 newspapers across the nation by the Newspaper Enterprise Association beginning this fall. The one-column cartoons, supplied by the Department, and credited to it, will appear on the NEA's News Visuals page at the rate of four-a-month. It is expected the cartoons will be used in newspapers at weekly intervals. (I) Washington, D. C.

Fact Sheets. The 12-page fact booklet, The War That Never Ends...Facts About Pest Control, was revised to include new material. This basic pest control publication was then reprinted with 26,000 copies distributed to the Nation's schools through the National Science Teachers Association with distribution expected to reach 60,000 by the end of this year. Another fact sheet, Your Home and Safe Use of Pesticides, has gone through a third reprinting with distribution totaling 90,000 copies. As part of its efforts to strengthen interdepartmental cooperation, the Department published the fact sheet, The Federal Committee on Pest Control, What It Is ...What It Does, and has distributed this sheet in cooperation with the FCPC. (I) Washington, D. C.

Publications. A 24-page illustrated booklet, "Our Struggle Against Pests," was prepared for use in the schools and with other youth groups such as the Boy Scouts. The first comprehensive reference guide on pesticide use for Extension Service and other educational workers, "Safe Use of Agricultural and Household Pesticides," was prepared in collaboration with other Federal agencies and will be distributed in the near future. "Use Chemicals Safely in the Production of Beef Cattle, Swine, Sheep," was issued as the first of a projected series of publications directed at specific users of pesticides. A booklet, "Saving the Forests," was produced to explain USDA forest insect and disease control programs to the public.

Approximately 60 additional Department publications were revised to update pesticide information in conformity with the Department's pest control policy, and the latest research developments on safety precautions and control methods. (I) Washington, D. C.

Exhibits. Two new pest control exhibits were produced, one highlighting Department policy regarding the safe, effective use of pesticides, and the other describing the functions of the Federal Committee on Pest Control. This latter exhibit was built for the use of the FCPC. These exhibits were displayed at national gatherings including the Public Symposium on the Scientific Aspects of Pest Control, American Chemical Society meeting, and

the National Pest Control Association convention, and were also seen at local events. (I) Washington, D. C.

Computer-Based System. A total of 35,206 references to worldwide literature on pesticides and pest control were indexed and announced through the biweekly indexing journal - Pesticides Documentation Bulletin. Approval has been granted by the Bureau of the Budget to continue the publication of this Bulletin through March 1968. (I) Washington, D. C.

Computer-Based Information retrieval System. Programs have been written and preliminary testing completed. The completed system is expected to be delivered third quarter of FY 1967. (E) Datatrol Corporation.

Yearbook. The 1966 Yearbook of Agriculture titled, "Protecting Our Food," discusses in depth the protection of our food supply from the ravages of pests, and the role of government in meeting the many challenges of pest control in the modern world. Contributors to this volume represent a variety of Federal and State agencies and private institutions involved in this field. With its balanced, comprehensive approach to pest control problems, the book represents a substantial contribution to the literature on this subject. It has received generally favorable reviews in the national press. (I) Washington, D. C.

Pestina Symbol. A campaign to enlist public cooperation in preventing the entry of foreign plant and animal pests gained added momentum with the designation of a new official USDA symbol, "Pestina," representing all foreign agricultural pests. The coquettish, hitchhiking bug appears on agricultural quarantine notices distributed by airlines, steamship companies, and travel agents. The name "Pestina" was suggested in a contest conducted by the Air Transport Assn. Transportation and travel organizations are cooperating in the intensification of this program. (I) Washington, D. C.

Schools. A close working relationship was developed with the National Science Teachers Association, a division of the National Editorial Association, with the objective of informing young people about the challenge of pests and their control. Informational materials suitable for classroom use have been prepared in consultation with the NSTA for distribution to junior and senior high school general science and biology teachers and their students. A pest control fact sheet was sent to 26,000 teachers, and a complete packet is being prepared for distribution. In addition, NSTA teacher-student magazines will carry articles on USDA pest control research and other activities. (I) and (E) Washington, D. C. and states.

Pesticide Educational Programs. The Department, working with other agencies and organizations, has a continuing responsibility of helping educate all segments of the public on safe and proper use of pesticides. Major objectives of the educational programs conducted this past year were: (1) expanding and maintaining a central chemicals information center in each State - these centers are sources of the latest information on chemical use, including laws and regulations on the persistency and toxicity of registered chemicals; (2) providing the public with facts on safe, effective pest control

control methods and an understanding of the necessity for using chemicals to insure the production of an adequate food supply and a wholesome, healthy environment; and (3) planning, developing and conducting regional, State and area training schools to provide county agricultural agents, commodity specialists and commercial pesticide applicators, dealers and producers with the latest information on safe and effective use of pesticides, integrated control and other aspects.

The objectives outlined were carried out by providing leadership, guidance and assistance to the States in helping them plan, develop and carry out a series of regional and national pesticide pilot projects designed to supplement their regular programs. These projects generally included: (1) training programs for applicators, dealers and producers; (2) development of a variety of exhibits, publications and audiovisuals; and (3) planning and conducting surveys in three States to provide guidelines for developing future educational programs on pesticides. (I and E) Washington, D. C. and State Extension Services.

Forest Insect and Disease Control Information Programs. One of the Department's prerequisites in carrying out forest insect aerial spray projects is to meet with local citizens through civic groups or meetings and inform, via discussions and special brochures, of the forest insect outbreak, its seriousness, proposed course of action, and what steps will be taken to insure that the pesticide will be applied safely. Federal, State, and private biologists are asked to participate and tell how distribution of pesticides in the environment will be measured.

This approach has, for a number of years, led to favorable public opinion and cooperation in large aerial spray projects for control of forest defoliators. (I and E) Portland, Oregon and Weyerhaeuser Company.

Programmed Instruction on Pesticides. The Department cooperated with the Colorado Extension Service in producing a programmed instruction training booklet for pesticide dealers. This course of instruction was developed from information obtained from a portion of a pilot survey conducted in Colorado to determine the attitude and knowledge of various audience groups. (I and E) Washington, D. C. and Colorado.

Applicator and Dealer Training Meetings and Schools. Training programs are being conducted for commercial aerial and ground applicators, dealers and producers. Curricula for these schools are related to the type of agriculture within the States and/or region. Clientele reached at the five regional applicator schools in the N.E. Region included personnel primarily concerned with aerial and ground application of pesticides on crops, range and forest lands and pest control problems in and around the home, commercial buildings and storage areas. About 30 additional aerial and/or ground applicator schools are planned over the course of the next three years in the Southern and Western Regions. All States held schools for dealers and 42 States held one or more applicator schools. Statistics from Georgia show that 116 training meetings involving 143

counties were held for dealers, custom applicators and formulators in fiscal year 1966. Total attendance represented over one-third of the States' dealers, plus others from applicator and formulator groups. A Statewide applicator, dealer, producer school held in January 1966 at the University of Illinois had a registered attendance of over 1200 persons. (I and E) Washington, D. C. and State Extension Services.

Chemicals Information Centers. The 50 States and Puerto Rico expanded and strengthened their central pesticide information centers in fiscal 1966. These centers, which operate under the direction of the chemicals leader/coordinator, serve as a source of information on all aspects of pesticide-chemicals such as registration, use, toxicity, persistency, degradability, safety precautions, equipment calibration, integrated control and residue tolerances and other aspects. (I and E) Washington, D. C. and State Extension Services.

Pesticide-Chemical Advisory Committees. An important aspect of an expanded chemicals education program has been the encouragement and development of State, university and county pesticide-chemical advisory committees. These committees function as advisory and planning bodies for educational programs concerned with the safe and proper handling, storage and use of all categories of pesticides. As of June 30, 1965, there were over 300 inter-agency, Extension, university, State and county pesticide-chemical advisory committees in existence. Today this number is estimated at well over 500 since a number of the States have developed county pesticide-chemical advisory committees. (I and E) Washington, D. C. and State Extension Services.

Coordination and Cooperation. Departmental pesticide information activities were coordinated by the Office of Information working with the Agricultural Research Service, Forest Service, Federal Extension Service, and other concerned agencies, and also through the Departmental Pesticides Committee. Cooperation was expanded with State agencies and private organizations such as The National Pest Control Assn., National Academy of Sciences, National Safety Council, National Education Assn., National Agricultural Chemicals Assn., and the Cooperative Extension Service.

The success of the Department's educational program is attributable to effective coordination and liaison. Department and the State personnel maintain with their counterparts in industry, government and other organizations at the national, State and local levels. This day-to-day contact makes it possible to work as a member of a team in the interests of the public we are paid to serve. Relationships and cooperation such as is effected today also makes it possible to react to emergencies immediately. (I and E) Washington, D. C. and States.

Information Subcommittee. Coordination with other Federal Departments was strengthened through the Information Subcommittee of the Federal Committee on Pest Control. The Department helped plan an FCPC exhibit and bulletin, and assumed all production costs for both items. A booklet describing the role of the FCPC and its member departments in the pest control field was

prepared with the assistance of the Department and will be published in the near future. In addition, improved interdepartmental cooperation was achieved through an arrangement providing for the exchange and clearance of pest control news releases and publications among the Departments of Agriculture; Interior; and Health, Education, and Welfare. (I) Washington, D.C.)

Departmental Pesticides Committee. Several USDA work groups were consolidated into this separate committee. It is a mechanism for intradepartmental coordination and provides guidance and recommendations for USDA members of the interdepartmental FCPC and its subcommittees. (I) Washington, D.C.)

Symposium on the Scientific Aspects of Pest Control. The national symposium was conducted through a contract with the National Academy of Sciences. Numerous Department scientists participated in and attended the symposium. (E) and (I), Washington, D.C.

Symposium of Aerial Application of Pesticides. Many Federal agencies participated in a USDA-sponsored symposium. (I) Davis, Calif.

Uniform Pesticides Act. Thirty-nine States have enacted an act developed by the Council of State Governments. A model law suggested by the Department was useful in drafting the Act. (I) Washington, D.C.

OECD Meeting. USDA research leaders participated in a meeting in France on the subject of "Unintended Occurrence of Pesticides in the Environment." (I) Washington, D. C.

United States-Japan Cooperative Science Program. The National Science Foundation sponsored the first joint panel meeting of this group on the subject of pesticides. USDA representatives participated in discussions with the Japanese about exchanges of scientists, information, and research materials and cooperative research projects. Three symposia on pest control subjects were planned. (I) Washington, D. C.

Additional information may be found on page A-81.

E X A M P L E S O F C H A N G E S
I N T H E P R O G R A M

The pesticide and pesticide related activities of the Department of Agriculture undergo constant review. These activities are never static but are continually adjusted to take advantage of new discoveries and to shift resources to where they can be best utilized. The fluid state of the activities can be illustrated by the following examples of lines of work initiated and terminated during 1966.

GENERAL

Initiated

Basic studies on the morphology of insect receptors stimulated by attractants (E) Rutgers Univ.

Determination of the biochemical mechanisms of dormancy in weed seeds (E) Mich. State Univ.

Host-parasite relationship of root-knot nematodes (E) Ind. Agr. Exp. Sta.

Biological control of plant feeding mites (E) Del. Agr. Exp. Sta.

Synergistic and additive effects in performance of herbicide combinations (E) Purdue Univ.

Development of micro-analysis techniques for detection of pesticides and their degradation products in cells and tissues (E) Pa. St. Univ.

The movement of chlorinated hydrocarbon insecticides in soils as related to soil properties and environmental factors (E) Univ. of Cal.

The metabolic response of rats to diets containing high levels of bromide residues (I) Beltsville, Md.

Terminated

Genetical studies of resistance in the German cockroach and the large milkweed bug (E) Va. Agr. Exp. Sta.

Laboratory studies on fumigation for control of cheese mites (I) Fresno, Calif.
Use of growth regulating substances for weed control (E) S. Car. Agr. Exp. Sta.
Pharmacologic study of chemical agents (E) Ill. Agr. Exp. Sta.
Microbiological studies of pesticide residues in soil (E) Puerto Rico Agr. Exp. Sta.

ANIMAL

Initiated

Evaluation of chemosterilants as means of control of Dermanyssecl mites on poultry (E) Miss. Agr. Exp. Sta.
Response of horn fly to extracts of animal tissues and to putrefaction products (E) New Mex. St. Univ.
Pathogenesis and control of trematode infections in sheep on irrigated pastures (E) Nev. Agr. Exp. Sta.
Biochemical effects of agricultural chemicals and control substances in livestock and poultry (I) Kerrville, Tex.
Effect of insecticides on the growth of microorganisms used in dairy products (E) Wyo. Agr. Exp. Sta.

Terminated

Blood loss and alteration of blood composition by internal parasites in sheep and cattle (E) Ala. Agr. Exp. Sta.
Pathogenesis and control of trematode infections in sheep on irrigated pastures (E) Nev. Agr. Exp. Sta.

FIELD CROPS

Initiated

Ecology and bionomics of the tobacco flea beetle in the Florida-Georgia cigar wrapper tobacco area (E) Fla. Agr. Exp. Sta.
The role of mites in the transmission of corn virus (E) Ohio Agr. Res. & Develop. Center.
Nature and control of peanut stunt virus (E) N. C. State Univ.
Biological factors associated with susceptibility and resistance of soybeans to toxin-producing molds (E) Univ. of Ill.

Integrated control of the cereal leaf beetle (E) Mich. Agr. Exp. Sta.

Effect of preparation and cooking on the pesticide residue content of selected vegetables (E) Univ. of Cal.

Terminated

Diseases of white clover and their interaction with insects (I) Durham, N. H.

Ecological factors affecting the abundance and cultural control of pink bollworm in Eastern Arizona (E) Ariz. Agr. Exp. Sta.

Biology and control of insect and bird pests of small grains and grasses (E) Ky. Agr. Exp. Sta.

Parasites and predators as factors in the ecology of rangeland grasshoppers (E) Wyo. Agr. Exp. Sta.

Improving grain marketability by controlling stored grain insects with aeration, fumigants, protective treatments and by reducing kernel fracturing (E) Wash. Agr. Exp. Sta.

HORTICULTURAL CROPS

Initiated

Replant problems in short life of peaches (E) Univ. of Ga.

Root rots of leguminous plants with special reference to snap and lima beans (E) Del. Agr. Exp. Sta.

Application of blacklight traps in controlling pecan insects (I) Albany, Ga.

Cause and control of diseases of ornamental crops in South Carolina (E) S.C. Agr. Exp. Sta.

Biological control of root rots of vegetables (E) Univ. of Wisc.

Mode of inheritance of pecan scab resistance in pecan (E) Miss. St. Univ.

Terminated

Epidemiology of tung diseases (I) Bogalusa, La.

Pathogenic decomposition of stored Alaskan vegetables (E) Alas. Agr. Exp. Sta.

Biology and control of nematode parasites on melons (E) Ind. Agr. Exp. Sta.

Epidemiology of stone fruit viruses (I) Madison, Wisc.

FORESTS

Initiated

Comparative physiology of varieties of Western white pine with respect to their reaction to the blister rust fungus (E) Univ. of Wisc.

Insects affecting pine cones and seeds in the Piedmont of Georgia (E) Ga. Agr. Exp. Sta.

Rearing the red oak borer on artificial diet for use in laboratory control studies (I) Delaware, Ohio.

A cooperative pilot study of cultural control of the red-pine cone beetle (I) St. Paul, Minn.

A system of sampling populations of Douglas-fir beetles in standing trees, logs, and windthrow at various periods during brood development (I) Boise, Idaho.

Terminated

Dispersal of the pine leaf aphid (I) New Haven, Conn.

Host-parasite interactions in oak-wilt development (E) Wisc. Agr. Exp. Sta.

Ecology and control of brush and other forest vegetation (E) Minn. Agr. Exp. Sta.

A P P E N D I X - A D D I T I O N A L
E X A M P L E S O F P R O G R E S S

TARGET I

TO GAIN KNOWLEDGE OF THE TAXONOMY, BIOLOGY, ECOLOGY,
PHYSIOLOGY, PATHOLOGY, METABOLISM, AND NUTRITION
OF PESTS AND HOST PLANTS AND ANIMALS

General

Transport and dispersion of fine spray particles. Theoretical and experimental studies on the transport and dispersion process for fine particles suspended in turbulent fluids were continued at the Pioneering Research Laboratory on Fine Particle Physics in cooperation with the Ohio Research Center. A large universal microscope has been adapted to continuously scan fluorescent-particle-traced aerosol deposits on solid surfaces. The instrument permits obtaining distribution profiles of particles deposited on plant leaf surfaces. Cooperative work with the Ohio Center concerned the diffusion of colloidal particles in an electric field when suspended in turbulent water. Instrumentation was developed for measuring particle concentration profiles and techniques for measuring turbulence with the aid of a Hot-film Anemometer. (I) Wooster, Ohio.

Distribution of spray material - helicopter. Investigations were made to determine the factors which govern the distribution of spray material from rotary wing aircraft. The most uniform distribution of spray deposit right and left of the flight centerline using a 28-foot boom was obtained with the aftmounted spray boom. An increase in application height of approximately 10 feet (from 8 to 10 feet to 20 to 25 feet) increased the effective swath width about 6 to 8 ft. Changing boom length from 28 ft. to 48 ft. increased the effective swath width about an equal distance. The uniformity of deposit across the swath increased as the flight speed increased. (I)
Forest Grove, Ore.

Metering solid pesticides from aircraft. A positive metering system for distributing solids from aircraft has been developed which has a capacity of 50 lb. per sec., independent of the quantity of material in the hopper. Another device has been developed to measure the instantaneous rate of flow of solid material from the aircraft, so that the pilot can adjust the flow without having to recalibrate the system. (E) Miss. Agr. Exp. Sta.

Soil Micro-organisms. Basic studies on the morphology of species of the imperfect genera Dactylium and Dactylaria have resulted in the clarification of their generic limits and publication of a proposal to conserve the generic name Dactylium. This conservation was necessary in order to protect the use not only of Dactylium, but also of Dactylaria, a genus of predaceous fungi of possible importance in the biological control of nematodes. (I) Beltsville, Md.

Identification and Nomenclature of Fungi. Identifications of miscellaneous fungi by staff members included 435 reported by letter and many others of local origin identified for technical workers and the general public. Some 2,041 identifications of fungi intercepted at United States ports of entry were made by the mycologist assigned to this work. Fungal, bacterial, and viral names in more than 60 manuscripts for publication by Department workers were checked for conformity to the International Codes of Nomenclature. The nomenclatorial catalogues were increased by 2, 470 entries, and records of 107 new genera were made in continuing preparation for issuance of a revised "general of fungi." (I) Beltsville, Md.

Taxonomy of Leaf and Stem Fungi. Taxonomic research utilizing comparative morphology was conducted on fungi of the ascomycetous family Dimeriaceae. Results showed that the genera Dimeriella, Episphaerella and Epipolaeum can justifiably be retained as valid genera, but that Wentomyces is a very doubtful genus which cannot be identified with any of the other three genera. Epipolaeum was found to be an epiphytic genus, whereas Episphaerella and Dimeriella penetrate host leaves. (I) Beltsville, Md.

Radar Tracking of Insects. In cooperation with the Johns Hopkins University Applied Physics Laboratory and the Air Force Cambridge Research Laboratory, initial experiments were made in the radar tracking of insects as part of a study of unexplained radar "echoes" from an apparently clear atmosphere. The work was done at Wallops Island, Virginia. Adults of the tobacco hornworm, corn earworm, and honey bee released individually at 8,000 feet altitude from an aircraft were followed in flight by blips on the radar screen. Data were obtained on flight path of the insect, speed of flight, changing altitude of flight, wing-beat frequencies, and periods of rest. These results not only explain some of the "echoes" encountered by radar equipment but also offer a new tool to entomologists in the study of the flying habits of insects. (I) Beltsville, Md.

Taxonomy of the Boll Weevil and Other Anthonomi. Research on the taxonomy of the boll weevil has enabled specialists to evaluate more fully some previously studied morphological characters which distinguish the boll weevil from its near relative on wild cotton, the Thurberia weevil. A preliminary key to distinguish the pupae of 42 species of Anthonomus and related genera has also been devised, and the larvae of about thirty species of weevils in the tribe Anthonomini are now known as a result of this investigation. (E) Tex. Agr. Exp. Sta.

Temperature Effects on Insects. The extent, nature, and significance of low

temperature adaptation and chill-coma in stored-product insects are being investigated. (E) Iowa State Univ.

Chemical stimuli to predaceous beetle. A number of fatty acids and protein hydrolysates are being tested to determine their attractiveness to coccinellid beetles. Early field studies show that corn of a certain genetic stock is more attractive to coccinellids than others, and that there might be an intra-specific attraction among the beetles themselves, possibly of a pheromone nature. These relationships are being tested under laboratory conditions and their causes are being investigated. (E) Univ. Minn.

Growth and metamorphosis of insects. The ecdysones (molting hormones) regulate growth and metamorphosis in insects. These compounds may offer considerable potential as insect control agents, and studies have been undertaken to learn more about their action and thus their potential use. Ecdysone titer has been measured throughout the pupal stage of the tobacco hornworm and two crystalline ecdysones have been isolated and identified from this species. In addition, an improved biological assay for use in ecdysone research has been developed. Work is now underway to study the effect of ecdysone on various developmental stages of insects to determine if these hormones may be used to block normal insect development. (I) Beltsville, Md.

Synthesis of insect hormones. A number of isoprenoid epoxide derivatives which exhibit extremely high juvenile and gonadotropic hormone activities have been synthesized and tested. One of these, the 10,11-epoxide of trans trans farnesenic acid methyl ester, is 1600 times as active as farenzol and in certain insects is the most active synthetic hormone-mimic of known structure reported to date. As little as 30 nanograms of this compound will interfere with the normal development of genitalia and block normal metamorphosis in the yellow mealworm. These compounds appear to readily penetrate the insect cuticle and interfere with the development of a number of insects at extremely low levels. This provides a basis for their potential use in insect control, either as chemical control agents or as a guide in the development of more potent insect hormone mimics. (I) Beltsville, Md.

Sex attractant of California red scale. Virgin female California red scales were found to produce a sex attractant. They were most attractive to males when 4 to 5 weeks old, but lost their attractiveness within 24 hours after mating. (I) Riverside, Calif.

Chemosterilant metabolism in house fly. Initial studies were made on the metabolism of C^{14} hempa by injecting into male house flies a dose which produces approximately 50% sterility. Ninety percent of the radioactivity could be recovered from the closely confined fly (15%) and its excreta (75%) after 24 hours. Only 1.25% is eliminated as respiratory $C^{14}O_2$. Flies permitted normal activity retained only 3% of the injected dose after 24 hours. (I) Beltsville, Md.

Caribbean fruit fly rearing. Laboratory tests showed that an introduced fruit fly Anastrepha suspensa, could be reared on the same larval medium formula used for the Mexican fruit fly. These flies can also be sterilized as pupae using gamma radiation. (I) Orlando, Fla.

Codling moth rearing. Research on physiology and nutrition of the codling moth has contributed to the development of a technique for rearing this insect on an artificial diet. This technique has permitted expansion of research on new approaches to control, such as sterilization techniques and sex attractants. (I) Yakima, Wash.

Fall armyworm mass rearing. A commercially available food packaging machine was modified to mass rear the fall armyworm. The machine fills one-ounce plastic containers with artificial diet, dispenses larvae on the diet, and caps the container in one continuous operation. Four thousand, five hundred containers can be filled in an hour. Larvae can be produced at a cost of \$9.20 per thousand, pupae for \$14.60 per thousand, and adults for \$16.50 per thousand. (I) Tifton, Ga.

Lygus bugs rearing. Three generations of Lygus lineolaris and two of L. hesperus were reared on artificial diets in the laboratory. A liquid diet with a water extract of alfalfa meal was the most satisfactory diet tested. In previous techniques lygus bugs have been reared on green beans, which is not too satisfactory for the production of large numbers. (I) College Station, Tex.

Lesser peach tree borer rearing. Studies have shown that lesser peach tree borers are sensitive to physical factors and disturbances. A special chamber developed to facilitate mating and oviposition, resulted in an increase in laboratory production to 7,000 moths per month. (I) Vincennes, Ind.

Salt-marsh caterpillar rearing. Salt-marsh caterpillars require linolenic acid in artificial diets. A satisfactory diet and rearing method have been devised and five generations of the insect have been reared. (I) College Station, Tex.

Cuban May beetle living preference. Studies have shown that Cuban May beetle larvae prefer to live in the top 3" of soil under the canopy of trees and in waste areas under Trema sp. and in St. Augustine grass sod. The adults mate at dusk and then feed on foliage of numerous trees and shrubs. (E) Fla. Agr. Exp. Sta.

Cabbage looper flight studies. Flight studies demonstrated that cabbage looper moths mounted on a flight wheel could fly as far as 32 miles in 24 hours when fed distilled water, but only 17 miles if starved. (I) Riverside, Calif.

Diapause of Codling moth. Studies on the influence of photoperiod on diapause of codling moths, showed that the critical period for Washington moths was 14.5 to 16 hours compared to 12 to 15 hours for California moths. Peak oviposition of the former occurred 3 hours prior to termination of the photophase. (E) Wash. State Agr. Exp. Sta.

Codling Moth Light Traps. Field studies showed that codling moths were recaptured at least a mile from release orchards. Blacklight traps hung at 10 feet above ground level captured more moths than those at 4 feet. Placing virgin females near the blacklight traps did not enhance the effectiveness of the traps. (I) Yakima, Wash.

Ecology of stored-Product Insects. Studies were initiated to determine the effect of humidity on the behavior of certain stored-product insects. Particular emphasis is being placed to study the importance of humidity as a stimulant for insect movement. (I) Savannah, Ga.

Nutrition of Stored-Product Insects. Under a cooperative agreement, studies were initiated to determine the basic nutritional requirements of the almond moth and the effect of each constituent on the insect's development. A joint study was started to develop or adapt methods for quantitative determination of food utilization and growth of two representative stored-product insects. After this has been accomplished, studies will be conducted on the relationship of food utilization and insect development. (I) Savannah, Ga. (E) Univ. of Fla; and Univ. of Ill.

Bionomics of Indian-Meal Moth. The bionomics of the Indian-meal moth are being studied. Various analytical methods in statistics for studying insect population have been developed. These will now be used to determine the influence of certain physical environmental factors on the population size and behavior of the Indian-meal moth. (E) Clemson U.

Infrared Stimulus to Indian-Meal Moth. Infrared has a highly stimulating effect on flight of the Indian-meal moth. After the moth's eyes were day conditioned or gated by a low intensity visible light source, moths flew continuously when exposed to infrared until death - at about 48 hours. (I) Tifton, Ga.

New Eriophyid Mites. Thirteen new species of eriophyid mites have been described and named. One species, Eriophyes pseudoinsidiosus, is of economic importance but had not previously been recognized as a species distinct from pear leaf blister mite, Eriophyes pyri. (I) Riverside, Calif.

Effect of Light on Growth of Submersed Weeds. The most important factor influencing the plant community in four south Florida canals was light as related to depth. Seasonal reductions in flow allowed gradual clearing of the water, greater light penetration, and increased weed growth. The high tannic acid concentration in some canals greatly reduced light penetration into the water and caused considerable reductions in weed growth. The plant succession pattern in the canals was algae to bladderwort to southern naiad to elodea. Either of the last two may form a "climax" vegetation. (I) Fort Lauderdale, Fla.

Nature of Dormancy in Weed Seeds and Buds. Electron microscopic studies of shepherdspurse (Capsella) embryos from an early stage through the mature seed showed a definite and consistent change in cell organelles with the approach

to maturity. The chloroplasts decreased in number and finally disappeared. Aleurone grains containing proteins were formed and increased in number and size and the number of spherosomes also increased greatly, both dominating the mature cells. Rabbits produced antibodies against the proteins of the aleurone grains. This appeared to be a suitable means of quantitatively measuring specific proteins. (E) Texas A&M.

Physiology of Dodder. Biochemical investigations on dodder and witchweed revealed that dodder contains a high concentration of starch and that the amount varies markedly with the particular region of the vine. The isolated granules were found to contain significant UDPG-starch-transglucosylase activity. A search for the enzyme in the granules isolated from host leaves yielded negative results. This research has considerable potential significance in the eradication and control of dodder in that it indicates a step in the intermediary metabolism which seems to occur only in the parasite and not in the host from which it draws nourishment. (E) PL 480 contract, Lucknow Univ., Lucknow, India.

Effects of Chemicals on Dodder. Basic studies of the effects of chemicals on growth movements in dodder have shown that very low concentrations of certain herbicidal chemicals, including CIPC, DMPA, DCPA, and trifluralin, can reverse the twining response to far-red application in this species. The twining response is necessary for attachment and parasitizing of the host plant. Indications are that very low concentrations of other metabolically active chemicals may be used to block crucial organ functions in weeds. (I) Beltsville, Md.

Nematode Taxonomy, Identification and Morphology. A monographic revision of the nematode genus Criconemoides, involving 85 species of plant parasitic nematodes, was completed; a new insect-parasitic nematode species that attacks the face fly was described; the classification of the insect-parasite family Allantonematidae was revised; and morphological variations were found that distinguish pathogenic populations of the soybean cyst nematodes from non-pathogenic populations. (I) Beltsville, Md.

Research Basic to Chemotherapy of Plant Viruses. Research has shown that increased chromosome complement of a systemic host of tobacco mosaic virus has no measurable effect on virus titer but increases the virus infectivity and decreases the effects of azo-guanine inhibition. Heat treatment inactivation of cherry necrotic ringspot virus in cucumber is reversible. (I) Wenatchee, Wash.

General aspects of research partially supported by Hatch and McIntyre - Stennis funds. Extensive basic research is in progress to develop safe methods of pest control. Studies have included research on the biology, physiology, life history and ecology of insects, weeds and plant and animal disease causing pests. Fundamental information was obtained on the selectivity, mode of action and metabolic degradation of pesticides. The development of pest resistance to pesticides was explored. Biochemical research was performed to determine the basis for attraction and sus-

ceptibility of plants and animal hosts to pest organisms. Species competition, food habits, host relationships and other areas were investigated to develop new leads to control. (E) All of the State Agri. Exp. Stats.

Animals

Metabolism of pesticides by animals. Studies on the metabolism in the animal of triazine herbicides have shown that 85 to 90% of these compounds and their metabolites are excreted in the urine and feces. The availability of carbohydrate appears to influence the urinary excretion. A large number of metabolites have been identified. The involvement of conjugation reactions in the metabolic pathways is suggested. Rumen microorganisms do not metabolize propazine and, at least in sheep, propazine is removed from the gastrointestinal digesta without rumen - reticulum microbial metabolism. Several of the other pesticides tested were metabolized by microorganisms. (I) Fargo, N. D.

Gastrointestinal Parasites of Lambs. Colostrum deprived, parasite-free lambs were found to be more susceptible to the effects of gastrointestinal parasitism than lambs raised to weaning age with their dams. In one experiment, all of the lambs were exposed to natural infection with miscellaneous internal parasites while grazing a pasture contaminated with infective larvae. In another experiment, the lambs were artificially infected with comparable numbers of larvae of the large stomach worm, Haemonchus contortus. In both instances, the colostrum deprived, parasite-free lambs had lower hematocrit levels and made poorer weight gains than the lambs raised with their dams, although, the worm loads were similar. (I) Beltsville, Md.

Dermal Immunity in Sheep Scab. The self-limiting phenomenon observed in infestations of common sheep scab appears to be due to a temporary, localized, dermal immunity in the host, rather than to strain exhaustion on the part of the parasitic mite. (I) Albuquerque, N. M.

Gapeworms of Poultry. The ultracentrifuge revealed that the hemoglobin from the gapeworm is a smaller molecule and/or has a different shape than the hemoglobin molecule of the host. This finding shows that the gapeworm alters host hemoglobin to form a new molecule for the worm's purposes. The electrophoresis apparatus also showed a difference between host and parasite hemoglobins. The gapeworm hemoglobin moved in a single zone with a relatively high velocity towards a positively charged electrode. In contrast, the turkey hemoglobin moved in two zones at a much lower velocity towards the same electrode. This finding shows that the gapeworm hemoglobin has a lower isoelectric point than has turkey hemoglobin. An alkaline denaturation experiment confirmed the differences found above between host and parasite hemoglobin. The parasite hemoglobin is rapidly denatured by alkali in less than 1/2 minute, but turkey hemoglobin is denatured hardly at all in 15 minutes. (I) Beltsville, Md.

Barium Antimonyl Tartrate reacts with Gapeworm Hemoglobin. The spectrophotometer revealed that a mixture of gapeworm hemoglobin and barium antimonyl tartrate absorbs more light of wavelengths near 542-576 mμ than does a solution of the hemoglobin alone. On the other hand, the spectrophotometer reveals that a mixture of turkey hemoglobin and barium antimonyl tartrate absorbs less light of wavelengths near 542 and 576 mμ than does a solution of the hemoglobin alone. This experiment thus shows that barium antimonyl tartrate reacts in a different manner with parasite hemoglobin than with host hemoglobin. (I) Beltsville, Md.

Biology of Demodex. Elucidation of the manner of transmission and length of the incubation period of Demodex spp. in livestock has progressed to the point of collecting the only known clinical case of demodicosis of sheep extant, and of determining that the incidence of subclinical demodicosis is high in native Southwestern cattle. Artificial transmission by various routes is so far unsuccessful. (I) Albuquerque, N. M.

Neoschingastia americana mite of turkeys. Basic research on the mite, Neoschingastia americana, a serious pest of turkeys, has shown that soil types and other environmental factors influence the abundance of these mites. Colonization attempts have been unsuccessful. (E) Univ. of Ga.

General aspects of research partially supported by Hatch and McIntyre - Stennis funds. Research was performed on both external and internal parasites of domestic and wild animals and poultry. Emphasis was placed on obtaining basic information on insects, nematodes and disease - inducing viruses of cattle, sheep, swine and horses. Information was obtained on pest bionomics, pathogenicity, ecology, distribution, artificial rearing, physiology and other areas. Transmission studies were performed primarily on anaplasmosis, piroplasmosis, avian leukosis and blue-tongue. Certain species of big game animals were surveyed to determine their parasite complex. Research was conducted on the metabolism and significance of pesticide residues in domestic and wild animals. Analytical techniques were evaluated to determine their accuracy and utility. (E) Agr. Exp. Stas. of: Ala., Alaska, Calif., Berkeley, Davis, Del., Fla., Ga., Idaho, Ill., Ind., Kan., Ky., Maine, Mass., Minn., Miss., Mo., Mont., Nebr., Nevada, N. J., N. Y., Ithaca, Okla., Oreg., Pa., S. C., S. Dak., Va., Wash., Wyo.

Field Crops

Cotton Cold Tolerance. From a series of low temperature screening studies, cotton selections have been made that will germinate and the seedlings will develop at a temperature 10°F below that usually considered to be minimum for cotton. The low temperature selections have a lower seedling mortality when exposed to the seedling complex than the parent variety from which the selections were made. This would suggest that the low temperature selections are more tolerant to the seedling disease complex or are able to develop more rapidly under adverse conditions and thus escape infection. (E) Tex. Agr. Exp. Sta.

Rust Fungi and their Parasites. Mycological research has been extended to investigations of the classification and biological relationships of the rust fungi. Initial emphasis has been on the "crown rusts" (Puccinia coronata complex), of particular importance as pathogens of oats and other small grains. Work during the year included the collection of specimens and the correlation of host and distribution data with morphological characteristics. Morphological features found to be of possible significance include teliospore sizes, pedicel length, and the forms of the crown digitations. As an adjunct study, research has been started on the taxonomy of Tuberculina, a genus of fungi parasitic on rusts. The genus may have some biological control potential, but has never been monographed. Preliminary results indicate that some species have been misplaced and should be referred to other genera. (I) Beltsville, Md.

Color phases of halophilic fungi. Biologic and taxonomic studies were made of brown and white fungal strains isolated from rough rice stored for 1-2 months at moisture contents between 14 and 15 percent. The strains were found to represent color phases of the same halophilic fungus. Heterocaryosis was commonly found in cultural studies, resulting in colonies with conidial heads of intermediate colors. The fungus, which grows rapidly on agar media containing 40-60 percent sucrose, was determined to be new and has been described as Eurotium heterocaryoticum. The fungus has an Aspergillus imperfect state and may be of some importance as a storage mold. (I) Beltsville, Md.

Aphid transmission of barley yellow dwarf virus. Basic insect research studies have indicated that barley yellow dwarf virus can be transmitted to and recovered from five varieties of sweet corn using the bird cherry oat aphid, Rhopalosiphum padi as the vector. (I) Brookings, S. D.

Methods of Control of Sweet Sorghum Leaf and Stalk Diseases. Further research to evaluate isogenic lines of the sweet sorghum variety Tracy were carried out. These studies included inoculation of selfed progenies and backcrosses of selected lines with spores of Colletotrichum graminicolum to determine resistance to the disease. Significant improvement in quality of the sirup from eight of the isogenic lines indicates the potential value of the technique. (I) Meridian, Miss.

Virulence of Root Rotting Fungi in Birdsfoot Trefoil. Pathogenicity of two species of Leptodiscus varied with temperature. Pathogenicity was enhanced at a soil temperature of 80° to 85°F. Culture experiments with the two species indicated that sclerotia are formed at a pH between 4.0 and 5.5. Sclerotia were not formed readily in media above pH 6.0. (I) Beltsville, Md.

Biology of Brown Stem Rot in Soybeans. The true asexual stage of the brown stem rot pathogen, Cephalosporium gregatum, was determined to be a synnema. When young, the synnemata have yellow stripes and red heads. Hence, the brown stem rot fungus appears as a species of Stilbella. This information enlarges our knowledge of the life history of the fungus, and may suggest control measures for brown stem rot. (I) Stoneville, Miss.

Biology of Resistance to Rust in Flax. Flax plants inoculated with an avirulent race of rust 24 hours before being inoculated with a virulent race produced fewer rust lesions than plants not previously inoculated with the avirulent race. These results were attributed to fewer infections and slower lesion development in the preinoculated plants. (E) N. D. Agr. Exp. Sta.

Biology of Safflower Resistant to Phytophthora Root Rot. Seedling resistance of safflower to phytophthora root rot is associated with lower content of pectic compounds and calcium. Hypocotyl tissue of resistant plants also contains a chloroform-soluble compound that strongly inhibits growth of *Phytophthora drechsleri* on culture media. Susceptible varieties had no inhibitory compound. (I) Beltsville, Md.

Metabolite of Alternaria tenuis Prevents Chlorophyll Formation. A fungus, isolated from diseased cotton seedlings has been found to produce an active fraction in liquid culture which prevents the formation of chlorophyll in most dicotyledonous plants. For instance, if seeds of cucumbers are soaked in culture filtrates of the fungus for 24 hours before planting, the resultant seedlings will be completely chlorotic. The active metabolite of the fungus apparently is active only in the dark and has no effect on seedlings that have already formed chlorophyll. (I) Fayetteville, Ark.

Discovery of Phytoalexin in Xylem Sap. Phytoalexins have been found in the xylem sap of infected cotton plants. The phytoalexin in sufficient concentration is capable of retarding or completely inhibiting the development of the verticillium wilt fungus. Germination of conidia are completely inhibited. (I) Davis, Calif.

Cotton Disease Complex - San Joaquin Valley. In the eastern portion of the San Joaquin Valley of California, a more virulent strain of the verticillium wilt fungus has apparently built up to the point where severe losses occur annually. Greenhouse inoculations have shown that the more virulent strain causes defoliation and in many cases death of the more tolerant commercial varieties. The same tolerant varieties show relatively mild reactions to the strain of the fungus which is usually isolated in other areas of the State. The widespread distribution of the virulent strain of verticillium in the eastern portion of the San Joaquin Valley probably accounts for the increased losses in that area. (I) Shafter, Calif.

Purification of sugarcane mosaic virus. Purification of the sugarcane mosaic virus for genetic studies is in progress. Column fractionation, centrifugation, and related techniques used up to date have not freed the virus of chlorophyll and similar cell components. Further research is in progress to purify the virus for genetic studies. (I) Beltsville, Md.

Determination of degrees of diapause in the cereal leaf beetle. An assay method suitable for determining degrees of diapause in the cereal leaf beetle has been developed. Serial sections of the brain and related glands are made, stained, and studied under the microscope. Neural-secretory cells and the corpora allata are more active in the post-diapausing larvae. (I) Lansing, Mich.

Reproduction and survival of cereal aphids. Color has a definite affect on the reproduction and survival of cereal aphids. In general, aphids reared under green and orange colors survived and reproduced better than those reared under other colors. (I) Brookings, S. D.

European corn borer resistance. DIMBOA, a constituent of corn tissue, was found to be a chemical factor in the resistance of corn to the European corn borer. Resistant lines of corn produce 10 times more DIMBOA than do susceptible lines. The possibility of using DIMBOA as a measure of resistance in corn hybrids and inbreds being screened in the resistant variety breeding program is being explored. (I) Ankeny, Iowa.

Resistance of maize to European corn borer. Basic research studies on the biochemical basis for resistance of maize to attack by the European corn borer were conducted. A technique was developed using carbon 14 to detect both DIMBOA and DIBOA, the chemicals believed to be associated with corn borer resistance in corn plants. (E) Iowa State Univ.

Biotypes of European corn borer. Field experiments conducted in Iowa have indicated that biotypes of the European corn borer exist in native field populations. Best criterion for separating biotypes appears to be diapause. More cultures from Minnesota had a higher percent diapause than those from Missouri. Those from Iowa were intermediate between the two. No biotype capable of damaging previously resistant crop varieties was found. (I) Ankeny, Iowa.

Alfalfa seed chalcid ovipositional response. Research has shown that there are chemosensory hairs on the ovipositor of the alfalfa seed chalcid which may influence oviposition. Of 81 chemicals occurring in alfalfa several have elicited an ovipositional response. (E) Univ. Wyo.

Boll weevil flights. In preliminary studies of the flight of laboratory-reared boll weevils in flight mills at Fort Detrick, Md., females averaged 1.43 miles and males 1.32 miles in initial sustained flights. In exhaustive flights females averaged 2.21 miles and males 2.06 miles. The longest exhaustive flight was almost 11 miles. Speed of flight on the mills ranged from 2.05 to 2.42 miles per hour. Flight activity was appreciably greater at 85° or 90°F. In studies in Kansas where cotton is not grown, boll weevils flew 10 miles within 48 hours from a release point to potted cotton plants. Releases were made at 5, 10, 15, 30, and 40 miles from potted cotton plants. Two weevils of 120,000 released at the 5-mile point and 2 of 248,000 released at the 10-mile point were recovered. None of approximately 225,000 released at the 15-, 30-, or 40-mile points were recovered. (I) State College, Miss.

Tobacco budworm mass rearing. Techniques have been developed for rearing large numbers of budworm larvae on a synthetic medium under laboratory conditions. Cannibalism among larvae has been overcome by using laying strips of medium on a wire mesh screen. (I) Oxford, N. C.

Tobacco hornworm rearing medium. A synthetic medium for rearing tobacco hornworms and techniques for handling these insects under laboratory conditions have been developed. (E) N. C., Agr. Exp. Sta.

Tobacco hornworm vision. Electrophysiological studies have indicated impairment of vision in newly emerged, laboratory reared, tobacco hornworm moths. Vision improved with age. Larvae of these moths were reared on a synthetic medium containing little or no visual pigment precursors normally found in living plants used as food. (E) Va. Poly. Inst.

Tobacco hornworm - mass rearing. Facilities have been developed for mass rearing tobacco hornworms on a synthetic medium for sterile moth releases and parasite propagation. Populations in excess of 2,000 larvae per week are being produced. Tobacco leaves are added to the medium to improve vision of the adult moths. (I) Oxford, N. C.

Witchweed in Corn and Sorghum, Seed Germination. Witchweed seeds buried for two years at depths up to 6 feet underwent a 20 percent reduction in viability. Application of a witchweed germination stimulant obtained from cotton to witchweed infested soil and sand causes high percentage germination in sand, but soil inactivates much of the stimulant. An unidentified mold occurring naturally on witchweed seeds inhibited germination. High levels of mineral nutrition partially offset witchweed damage to corn without benefiting the weed. These findings are helpful in our efforts to eradicate witchweed through prevention of new seed production, and in reducing losses before eradication is achieved. (I) Whiteville, N. C.

Differential Varietal Response to Herbicides. Varieties of wheat respond differently to treatment with the herbicide, dicamba. Dicamba, at 1/2 lb/A, did not affect yields of a resistant variety of wheat, but reduced the yield of a susceptible variety by 40 percent. Bluebonnet 50, a 150-day maturing rice, and Nato (130-day) competed significantly better with barnyardgrass than did Vegold, a variety which matures in approximately 110 days. These studies are further examples of progress that can be obtained through investigation of weed science aspects of genetic constitution of plants. (I) Stuttgart, Ark. and (E) Univ. of Minn.

Weed Competition in Sugarbeets. Sugarbeets, when kept free of kochia for the first five weeks after planting or until June 4, had only a light reinfestation of kochia at harvest which did not significantly reduce root yields of gross sugar. On the other hand, neither root yields or gross sugar were decreased where kochia competed with beets for the first eight weeks, provided that all competition was removed at that time. Root yields and gross sugar were decreased proportionally by increasing the period of kochia competition. (I) Fort Collins, Colo.

Root-knot Nematode and Mold Development in Peanuts. Aspergillus flavus was greatly increased in peanuts that were infected with root-knot nematodes. (I) Tifton, Ga.

Mycotoxins in Soybean Seed. Eleven cultures of Aspergillus flavus were obtained from 1232 samples of 1964 seed. No more than one culture was isolated from any sample, indicating that no sample was uniformly or heavily contaminated. Two isolates have been tested for aflatoxin production. One did not produce any detectable aflatoxin and the other produced 100,000 ppb of B₁ component. No cultures of A. flavus were isolated from about 1700 samples of 1965 seed representing about 10 varieties at each of 12 locations from Minnesota to Florida, collected periodically from six weeks prior to until six weeks after maturity. (I) Ames, Ia; Urbana, Ill; Lafayette, Ind; Raleigh, N. C.; Stoneville, Miss. and (E) the Agr. Exp. Stas. of Del., Fla., Ind., Iowa, Minn., and Mo.

General aspects of research partially supported by Hatch and McIntyre - Stennis funds. Research on microorganisms, insects, depredating birds, weeds and nematodes that affect field crops has been done. Studies included the effects on pests of environmental factors such as soil microorganisms and plant nutrients, moisture availability, competition, temperature, light and others. There was considerable research on developing artificial rearing techniques to facilitate other investigations. Information was obtained on pest distribution, dispersal, life history, population dynamics, host plant relationships, genetic variability, physiology and biochemistry. Plant disease etiology, transmission and host reservoirs also were studied. Research was performed to determine the nature of pest resistance to pesticides as well as their effects on the crop plants. (E) Agr. Exp. Stas. of: Ala., Alaska, Ariz., Calif., Berkeley, Davis, Colo., Del., Fla., Ga., Haw., Idaho., Ind., Iowa, Kan., Ky., La., Mass., Mich., Minn., Miss., Mo., Mont., Nebr., Nev., N. H., N. J., N. Mex., N. Y., Ithaca, N. C., N. Dak., Ohio, Okla., Oreg., Pa., P. R., R. I., S. C., S. Dak., Tenn., Tex., Utah, Va., Wash., W. Va., Wis.

Horticultural Crops

Russet Crack of Sweetpotato. Necrotic leaf spot symptoms of the heat-stable russet crack virus can remain masked when the internal cork syndrome is present. All Jersey-type varieties usually exhibit both root and foliage lesion symptoms of this disease. Foliage symptoms have remained masked in all other crack-susceptible varieties tested to date at Beltsville. A survey made in October 1965 on the incidence of russet crack in sweetpotato-producing States, showed that this disease is widespread in New Jersey, Maryland, and Virginia. So far, no effective method has been devised for the control of this disease. (I) Beltsville, Md.

Epidemiology of Stone-fruit Viruses. Spread of X-disease virus is rapid within Utah sweet cherry orchards and removal of diseased trees has not curbed the spread. Bark ring grafts of mahaleb cherry around sweet cherry branches failed to prevent movement of X-disease in the limb. Hudson sweet cherry is sensitive to severe strains of rusty mottle virus and may prove to be the most reliable index host for viruses of this group. The sweet cherry

varieties Ulster, Chinook, and Rainier appear to be tolerant of necrotic rusty mottle. (I) Logan, Utah.

Epidemiology of Citrus Virus Diseases. Indexing tests were used to study the severity of the tristeza virus that is killing sweet orange trees on sour orange rootstock. Two California selections of Etrog citron proved to be rapid and sensitive indicators for exocortis virus under Florida conditions. Meyer lemons in Florida contain tristeza virus alone, tristeza plus tatter leaf virus, and tatter leaf virus alone. Tatter leaf is easily transmitted to different citrus hosts and to a number of herbaceous plants. Incontrovertible evidence was obtained that psorosis virus is transmitted through seeds of Carrizo citrange to a large degree. (I) Orlando, Fla.

Epidemiology of Stubborn Disease of Citrus. Unbudded Cleopatra mandarin seedlings apparently carry a graft-transmissible disorder that resembles stubborn disease. Suitable indexing techniques for stubborn disease are still being sought. Leaf samples from stubborn-affected trees were lower in zinc content than those from trees free of stubborn. (I) Indio, Calif.

Etiology of Bunch Disease of Pecan. Bunch disease causes a bushy growth of slender willowy shoots from an abnormal forcing of lateral buds. Heavily infested trees become progressively weaker and die prematurely. Thirty-four of approximately sixty pecan varieties under test appear to be moderately to highly susceptible to bunch disease. (I) Shreveport, La.

General aspects of research partially supported by Hatch and McIntyre - Stennis funds. Research has been conducted on insect, plant disease, nematode, depredating bird and weed problems on horticultural crops. Emphasis was placed on biological, ecological and physiological studies. Considerable information was obtained on the transmission of various pathogens. Research also was done on host-parasite relationships and other problems. Biochemical studies were performed to determine the metabolic effects of pests and pesticides on horticultural crops. Studies of air pollutant effects were included. Data also were obtained on the translocation of pesticides in plants. Information was obtained on marketing and storage pests as well as on production problems. (E) Agr. Exp. Stas. of: Ala., Alaska, Ariz., Ark., Calif., Davis, Riverside, Colo., Conn., Del., Fla., Ga., Haw., Idaho, Ill., Ind., Kan., La., Maine, Md., Mass., Mich., Minn., Miss., Mo., Nebr., N. H., N. J., N. Y., N. C., N. Dak., Ohio, Ore., Pa., R. I., S. C., Utah, Va., Wis.

Forests

Artificial diets of forest insects. Artificial or semi-artificial diets are generally needed for producing the large numbers of insects needed for intensive studies in physiology, toxicology and other insect research areas. An artificial diet that was developed for bark beetles has been successfully modified for rearing the pales weevil, an important pest of seedlings.

Also an artificial diet for Dioryctria abietella, an important cone destroying insect, was greatly improved through addition of several carbohydrates which were identified in young pine cones. (I) Olustee, Fla.

Air pollution damage to white pine. Eastern white pine seedlings were set out in Tennessee where high concentrations of sulfur dioxide occur and in Alabama where there are high concentrations of fluorides. Most seedlings were injured by both gases, some only by sulfur-dioxide, others only by fluorides. A few were uninjured by either pollutant. Susceptible and resistant trees will be tested further to develop a series of variously affected trees that will serve to monitor the air over large areas. (I) Asheville, N. C.

Water storage of stockpiled wood. Water spray storage of green roundwood is receiving increasing attention as a method of reducing insect and fungus-caused losses in stockpiled wood raw materials. Because of its ease of use and the reported absence of appreciable insect or fungus attack in research and field trials the method has been readily accepted. (I) Gulfport, Miss.

Effect of gas concentration on rate of decay. Researchers have studied the relation between oxygen and carbon dioxide concentration and dry weight production of decay fungi in an attempt to determine their effect on rate of decay. Dry weight production of each of four decay fungi increased rapidly with increase in oxygen to 15 percent and decreased with increase in carbon dioxide to 30 percent. Samples of these gases from tree trunks are being analyzed to determine the significance of the laboratory results. (I) Delaware, Ohio.

Biochemistry of decay of forest products: The production of oxalic acid and the apparent non-production of cellulases by brown rot fungi has led to the finding that oxalic acid alone can cause considerable deterioration of the sweetgum sapwood used in early studies. (E) N. C. State Univ.

Wood-inhabiting Forest Fungi. Research on the taxonomy, biology, and ecology of wood-inhabiting forest fungi during the year included both wood-rot and imperfect fungi. Three new species, Botryobasidium croceum, Tharopana mississippiensis, and Harpographium zonatum were discovered, named, and described. Dactylium leptosporum was found to be a distinct species, rather than a subspecies of D. dendroides. Melanographium citri was found for the first time to occur in the United States and three other fungi were determined to be first reports from Mississippi, where all four had been collected. (I) Beltsville, Md.

Losses from Schleroderris and associated cankers. During the past year evidence has accumulated that the fungus Schleroderris lagerbergii is not responsible for all the losses to red and jack pine that have been ascribed to it. Several other organisms have been isolated from Schleroderris-like cankers. A study of the development of the disease and of the fungi that appear to cause it is underway. (I) St. Paul, Minn.

Differentiation of fungi spores. On the basis of antigen-antibody tests, spores of fusiform rust and eastern gall rust are distinct. This is the first valid and consistent means of differentiating between the spores of these two fungi. In order to put programs of breeding for fusiform rust resistance, as well as other rust research programs, on a sound basis, it must be known specifically what fungus is being dealt with. (I) Durham, N. C.

Biology of comandra rust. Weather conditions that favor or prevent the production and germination of the pine-infecting spores of comandra blister rust were described to provide a basis for understanding the long intervals between rust outbreaks and for controlling outbreaks or minimizing their effects. (I) Logan, Utah.

Investigation of eastern white pine mortality. Preliminary investigation of an unexplained dying of eastern white pine indicates that trees succumb as a result of girdling cankers that follow root infection by fungi. Several fungi have been isolated from diseased trees and are currently being evaluated for pathogenicity to eastern white pine. (I) Delaware, Ohio.

Timing of bark beetle controls. Studies on the physical behavior of the southern pine beetle, an important killer of southern pines, have shown that the part of the tree attacked and the proportion of the brood surviving vary greatly through the season. This has important implications with respect to control practices, indicating that they may be effectively undertaken mainly in the fall, winter and early spring. (I) Alexandria, La.

Relationship of bark beetle attack to soil drainage. In studies on southern pine beetle ecology in Louisiana, observations pointed to differences in stand susceptibility to beetle attack associated with soil moisture. The infested areas included poorly drained flats and island-like hummocks known locally as "pimple mounds." Poor drainage on the flats appears to be associated with factors predisposing trees to beetle attack. (I) Alexandria, La.

Effect of temperature on Douglas fir beetle. There are few cases in forest entomology in which factors responsible for collapse of an infestation are thoroughly understood. One of these was recently observed in southern Utah, involving the Douglas-fir beetle. In this instance an infestation was terminated when brood remained in the infested trees over two winters, presumably as a result of prolonged subnormal temperatures, and failed to emerge. (I) Moscow, Idaho.

Natural control of the black-headed budworm. In southeast Alaska, egg surveys are commonly made in the fall to predict the character of black-headed budworm populations the following year. However no information has been available on overwintering egg mortality, and this has sometimes seriously affected the accuracy of predictions. A recently completed study covering three seasons disclosed that about 30% of the eggs do not hatch. The main cause for this egg mortality is snow and ice sliding over the foliage and shearing off the eggs.

With this information more reliable predictions can now be made. (I)
Juneau, Alaska.

Taxonomic and distribution studies of acorn weevils. Weevils of the genus Curculio attack acorns throughout the United States and sometimes severely limit their production. Host relationships, life cycles, host-parasite interactions and other biological data have been determined for most of the weevils in the genus and a monograph is in preparation. This information, along with that already published on the weevil genus Conotrachelus, will complete taxonomic and distribution studies on the weevils attacking acorns in the United States and will provide background information for further investigations on controlling the species that are most destructive to acorn crops. (I) Delaware, Ohio.

Dwarfmistletoes seed dispersal. Basic knowledge of the seed dispersal mechanism of the dwarfmistletoes leads to new insights on the control problem. High-speed photographic measurement of dwarfmistletoe seed velocities suggest that the larger dwarfmistletoes have higher velocities resulting in greater seed flight distances and faster rates of spread. Heavier pruning and wider tree spacing may be necessary for their control. (I)
Fort Collins, Colo.

Douglas-fir root nematodes. A new species of nematode was observed infesting mycorrhizae of a pole-sized Douglas-fir in western Oregon. Of the six different types of mycorrhizae found on the tree's root system, the nematode was absent on four, occasional on the fifth, and abundant on the sixth. Apparently the fungi that produced the first four types of mycorrhizae in some way repelled the nematode. Understanding of the nature of this repellent could lead to biological control of this and other nematodes. (I) Corvallis, Ore.

General aspects of research partially supported by Hatch and McIntyre - Stennis funds. Basic research on forest pests is concerned principally with insects, disease producing organisms and undesirable woody plants on both conifers and deciduous trees. Studies on insects included biological and ecological research, particularly on life histories, the influence of natural enemies, tree vigor and environmental factors such as temperature, moisture and humidity on pest population development. Investigations on plant diseases were concerned principally with the nature of pathogens, their interactions with and transmission between host plants, the genetics of disease resistance, pathogen survival and other factors. Information was obtained on the development of infestations of undesirable woody plants, their physiology, metabolic response to herbicide applications and other factors. (E) Agr. Exp. Stas. of: Ala., Ark., Calif., Davis and Berkeley, Conn., Fla., Haw., Ill., Ind., Kan., Maine, Mass., Minn., Miss., Mo., N. J., N. Y., Ithaca, Okla., Ore., Pa., R. I., Tx., W. Va.

TARGET II

TO IMPROVE AND DEVELOP MEANS OF CONTROLLING
PESTS BY NONPESTICIDAL METHODS

General

Summaries of Disease Resistance. During the year phytopathologists of the Regional Plant Introduction Stations compiled disease resistance summaries for carrot, onion, pumpkin-squash, and southern pea (cowpea). These summaries listed all published sources of resistance in these crops. (I) Experiment, Ga; Ames, Iowa; Geneva, N. Y. and Pullman, Wash.

Repellancy of chemicals to insects. Of 46 new compounds synthesized, 9 of 21 carbamates, 2 of 6 maleimides, and 3 of 6 trinitrobenzenes showed greater repellency than the synergized pyrethrum standard. (E) Midwest Research Institute.

Diseases of insects. Several species of Entomophthora were found infecting diseased aphids and banded cucumber beetle larvae. Another fungus, Metarrhizium anisoplias, gave complete kill of second instar banded cucumber beetle larvae and first instar larvae of Mexican bean beetle larvae. (I) Charleston, S. C., and Presque Isle, Maine.

Attractant for dermestid beetles infesting dairy products. About 30,000 female black carpet beetles are reared each month for collection of sex attractant either by aeration or by maceration in benzene. The active components can be manipulated by high-vacuum short-path distillation, column chromatography, thin layer chromatography and chemical treatment but not by gas chromatography. The threshold of response of the males generally occurs at a concentration of 1/10,000 female equivalent. The preliminary work conducted indicated that full-scale attempts to isolate and identify the active compounds can now be undertaken. (I) Fresno, Calif., and (E) Stanford Research Institute.

Insect Barriers in packaged foods. Several types of styrene, saran, and ethylene systems as barrier coatings for prevention of insecticide migration through food packages have been prepared and sent to Savannah, Georgia, for evaluation. Saran and ethylene/vinyl acetate wax coatings appear promising as barriers when one or two of these materials were applied over a styrene/butadiene undercoat. (E) Battelle Memorial Institute.

Insect-resistant packages for food. Large-scale overseas shipping and storage tests have shown insect-resistant multiwall paper bags to be very effective in protecting dry foods against outside insect infestations. To provide maximum protection, the bags must have insect-tight closures and a synergized pyrethrum coating on the outer surface of the bags. Laboratory evaluation of 57 candidate repellents revealed 17 were more repellent to insects than is the synergized pyrethrins standard. Laboratory tests showed that saran films and coatings and polycarbonate, polyvinyl alcohol, and unplasticized polyvinyl chloride films are effective barrier sheets for preventing the migration of repellents into food packages. Laboratory tests showed cotton bags treated with synergized pyrethrum and having overtaped seams protected the contents from outside insect infestation. (I) Savannah, Ga.

Brown soft scale parasites. Studies showed that no parasites of the brown soft scale were found in 20 survey groves in Texas. In other groves 90% of the parasites found were Coccophagus lycimnia. Another established parasite was Microterys flavus. Attempts are being made to establish another parasite Encyrtus lecaniorum which has shown promise as a brown soft scale parasite in field cages. Rearing methods for the parasites are being developed in preparation for mass rearing and release experiments. (I) Weslaco, Tex.

Cabbage looper - light trap studies. Studies have shown that cabbage looper moth catches were increased significantly in blacklight traps baited with the synthetic sex attractant. (I) Quincy, Fla.

Cabbage looper - blacklight traps. Blacklight trap catches of male cabbage looper moths were increased from 4 moths per trap per night to as high as 95 by caging virgin females near the traps. Catch of female moths was not affected. Similar increases in catch of males were observed when a synthetic sex pheromone was substituted for the caged virgin females. The response of cabbage looper moths to blacklight traps baited with virgin females was greatest from midnight to 4 AM and was least from 6 to 10 PM. Some marked moths were recaptured in traps up to a week after release and as far as 10,000 feet from the release point. (I) Riverside, Calif.

Parasitic control of cabbage looper. Studies in the laboratory showed that mass rearing of parasites for control of the cabbage looper on cotton may be feasible. Capidosoma truncatellum (Dalm), an encyrtid parasite collected locally on the cabbage looper, was reared to develop mass rearing methods. This parasite, which has polyembryonic reproduction, may produce as many as 3,000 adults in a single host larva. Parasitism was as high as 89% in some exposed groups of cabbage loopers reared on artificial media. The

number of adult parasites developing per host larva varied considerably but the number from the higher yielding ones compared favorably with the field-collected material. (I) Brownsville, Tex.

Cabbage looper and fall armyworm - nuclear polyhedrosis virus. Sprays containing nuclear polyhedrosis virus plus *Bacillus thuringiensis* resulted in 50% of cabbage plants being free of cabbage looper and fall armyworm damage, compared to 5% of untreated plants in a test at Charleston, S. C. Over half of a group of field-collected cabbage looper larvae were found to be infected with a fungus, *Spicaria rileyi*. Five percent of the larvae were parasitized by a wasp, *Copidosoma truncatellum*. (I) Charleston, S. C.

Citrus red mite - virus disease. Surveys have shown that natural infections of a virus disease of the citrus red mite occurred in 53% of groves examined in Central and Southern California. A natural epizootic of the virus in a grove near Riverside reduced the mite population and a low population has continued for the past 1 1/2 years. Results of orchard tests of applications of citrus red mite virus suspensions and living infected mites were inconclusive. (I) Riverside, Calif.

Codling moth parasite production. Laboratory production of the egg parasite, *Trichogramma minutum*, was increased to about 10,000 per week by increasing relative humidity to 70-85%. Emergence of adult parasites from codling moth eggs was increased from 40 to 77% under these conditions. Rearing methods now appear to be satisfactory for use in large scale rearing and release experiments. (I) Vincennes, Ind.

Fall armyworm - sterilization. Research studies to find chemosterilants for sterilizing fall armyworm were continued. One hundred percent sterility was achieved when males or females of the fall armyworm were forced to walk over a felt pad saturated with a 10% sucrose solution containing 0.3 to 0.15% tepa. This technique for sterilizing moths will be used in tests in conjunction with light traps to trap, sterilize and release moths, back into their wild environment. (I) Tifton, Ga.

Nonchemical control of flies. Investigations on nonchemical methods for controlling flies around dairy barns showed that removal of fly-attractive materials from a dairy complex reduces the house fly population by about one-third. Stable flies were not much affected by barn and corral cleanup. A pasture study showed that more house flies were attracted to ultraviolet lamps than other flies. Similar results were obtained in a loafing shed. Several face flies were attracted to the lamps in the loafing shed, contrary to the common belief that these flies are not found inside barns unless seeking over-wintering sites. (I) Beltsville, Md.

Nematode infestation of face flies. A laboratory culture of face flies at Columbia, Missouri, was found to be infested with a species of nematode known previously only from New York State. The rather complicated life cycle of this nematode was worked out to determine which of its developmental stages might be responsible for any reduction in face fly populations, and

studies are continuing to assess the nematode's possible economic importance.
(I) Columbia, Mo.

Grasshopper control by pathogens. Three protozoans and a virus infecting grasshopper are being evaluated as possible means for controlling these insects. One protozoan, Nosema locustae, has been successfully established in the field. A new species of Nosema isolated from grasshoppers causes tumors which produce lesions in the digestive tract resulting in death. A third protozoan, Malamoeba locustae, infects the digestive tract causing reduced vitality and fecundity. A polyhedral virus recently isolated from grasshoppers infects the fat bodies causing reduced fecundity and early mortality. (I) Bozeman, Mont.

Flame destruction of winter hosts of green peach aphid. Studies showed that drainage ditches provide protection during the winter for summer forms of the green peach aphid and their weed hosts, many of which are sources of beet western yellows virus. Destruction for the second year of weeds along irrigation and drainage ditches and canals by burning resulted in 74% fewer beets in the test area with symptoms of the disease which is transmitted by these aphids. (I) Yakima, Wash.

Japanese beetle control with low-volume applications. Low-volume applications of malathion at 8 ounces per acre killed 90-95% of Japanese beetle adults. Eight applications at 5 to 7 day intervals were used to suppress adult populations. However, honeybees in unprotected hives and other beneficial species of insects were killed by these applications.
(I) Moorestown, N. J.

Japanese beetle - trapping. In an area-wide population suppression experiment on Nantucket Island over 22,000 Japanese beetles were captured in 2286 traps placed within the 6000 acres infested. Most of the traps were baited with anetholeugenol. Over 18,000 bumblebees also were caught in these traps.
(I) Moorestown, N. J.

Japanese beetle sterilization. Japanese beetle adults were sterilized by exposure to surfaces treated with 0.06% tepa for males and 1% for females. Males dipped in 0.06% tepa also were sterilized. Tepa residues on the treated beetles of 19.9 micrograms were reduced to 3.2 ug after 48 hours.
(I) Moorestown, N. J.

Mexican fruit fly - baits. A protein hydrolysate-borax pellet was developed for use in baiting liquid traps used by pest control and regulatory programs to survey for Mexican and other species of fruit flies. The pellets simplify handling and mixing of the liquid baits. (I) Mexico City, Mex.

Fish for mosquito control. Behavior and food preferences of introduced annual fishes in relation to mosquito control are being investigated. Some species of tropical fish that lay eggs which remain dormant until flooding, as do the aedine mosquitoes, are being studied as potential biological control agents. (E) Univ. Calif., Riverside, Calif.

Pathogen infestations of mosquitoes. Research has shown many species of important mosquitoes are naturally infested with protozoons, bacteria, fungi, nematodes, and a polyhedral virus. The most prevalent pathogens were microsporidia (protozoa), a bacterium (Spirillum) and fungi (Coelomomyces). Several pathogens are highly lethal to mosquito larvae. However, infection levels are generally low in natural populations. Research is continuing to determine factors important in pathogen adaption to environment and mechanisms of host infection to develop these agents for control.

(I) Lake Charles, La.

Peach tree borers - sex attractant. Females of both the peach tree borer and the lesser peach tree borer produce strong sex attractants. The former species produces the attractant at about noon and are most attractive to males on the 2nd and 3rd days after adult emergence. Sticky board traps baited with virgin females attract and capture responsive males. Traps baited with virgin female lesser peach tree borers are being used in a 45-acre orchard in Indiana to determine effectiveness of the male annihilation technique for lesser peach tree borer control. (I) Vincennes, Ind., and Ft. Valley, Ga.

Effect of stress on stored product insects. Research was started in cooperation with the University of Florida to study about 25 species of stored-product insects for the emission of sounds of biological importance under both normal and severe stress conditions. Any recorded sounds will be investigated to determine whether it can be used effectively to detect the presence of, attract, repel, or alter the behavior of individuals of that species. (I) Savannah, Ga., and (E) Univ. of Fla.

Controlled atmospheres for stored-product insects. Trogoderma glabrum larvae were exposed 2, 4, and 7 days in wheat in towers purged with nitrogen and carbon dioxide. At 100 and 200 cc./min. nitrogen and carbon dioxide reduced the oxygen concentration to about 1 percent in 1 day. At the higher purging rate, carbon dioxide killed 98 percent of the larvae within 4 days, while nitrogen killed only 65 percent within 7 days. At 100 and 50 cc./min. carbon dioxide killed 100 and 89 percent of the larvae, respectively, within 7 days. Red flour beetle adults were exposed to nitrogen and carbon dioxide purging for 6 and 24 hours in towers containing shelled and inshell peanuts. An average of less than 2-percent mortality occurred among the insects exposed for 6 hours only. Carbon dioxide purging for 24 hours at 100 and 200 cc./min. killed an average of 47 and 81.5 percent of the insects, respectively, in the inshell peanuts. However, a mortality of only 22 and 60 percent of the insects, respectively, occurred in the shelled peanuts. Nitrogen at 200 cc./min. killed only about 7.5 percent of the insects in inshell peanuts, while about 60 percent of the insects in the shelled peanuts were dead. (I) Savannah, Ga.

General aspects of research partially supported by Hatch and McIntyre - Stennis funds. Progress has been made in general lines of research in the biological control of insects and mites with parasites, predators and pathogens; the control of plant diseases including nematodes; and the

control of weeds with insects. Adequate dosages of Heliothis zea polyhedrosis virus applied to cotton and sorghum gave excellent control of H. zea. Non-amino acid fraction of root exudates from marigold, orchard-grass, timothy, red clover and corn inhibited egg hatch of a common root knot nematode.

(E) Agr. Exp. Stas. of: Ala., Ariz., Ark., Calif., Berkeley, Davis, Riverside, Conn., New Haven, Del., Fla., Haw., Ida., Ind., Iowa, Kan., Mich., Minn., Mo., Nebr., N. Mex., N. Y., Ithaca, N. Y., Geneva, Ohio, Oregon, Pa., P. R., S. C., S. Dak., Va., Wash., Wis., Wyo.

Insects to control alligatorweed. Studies in Argentina on the biology of the alligatorweed thrips, which is being investigated for introduction into the United States as a possible control agent for that weed, show the mechanisms by which it is able to disperse. This insect appears to be restricted in its host preferences and to be adaptable to North American climates where alligatorweed is a problem. Field observations of Vogtia malloi, a phycitid moth found to attack the stems of alligatorweed in Argentina, are being made to determine its life history and ecology. Host-plant cultures are being prepared to facilitate laboratory rearing of this insect for studies of its host specificity. Castetar, Argentina.

Foreign Plant Pathogens for Weed Control. In preliminary searches for pathogens on weeds conducted in Italy and Sudan, a severe leaf spot caused by Ramularia sp. was observed on Canada thistle and may have potential in the United States. Also, rust (Puccinia xanthii Schw.) was abundant on cocklebur, especially near the sea. Much more extensive surveys and studies are planned for 1966-67. (E) Stanford Research Institute.

Parasitic infections terminated chemically. Infections of guinea pigs with Trichostrongylus colubriformis were terminated chemically 2, 5, and 12 days after oral inoculation with normal infective larvae. Parasitic stages of development on these days were: third, fourth, and fifth, respectively. Infections consisting of only parasitic third-stage worms resulted in a high degree of immunity to reinfection, fourth-stage worms provided no significant additional protection, and infections terminated after worms had reached the fifth stage resulted in almost complete immunity. Chemically terminated parasitic third- and fourth-stage infections failed to provide immunity against reinfection in lambs. The immune response in guinea pigs was directed against parasitic third- and fourth-stage worms of the challenge inoculations, and immunity was not fully expressed, as reflected by maximum elimination of worms, until 9 days after challenge. (I) Auburn, Ala.

Biological Control of Nematodes. A small rhabdocoel flatworm was found preying on root-knot nematodes; greenhouse studies indicate it depresses soil populations of plant parasitic nematodes. This newly discovered flatworm represents another natural biological control agent heretofore unknown. Rotation studies showed that damaging numbers of nematodes did not develop on virgin land cultivated to Crotalaria and marigolds, indicating that if proper rotations are followed new agricultural lands may not necessarily suffer the damages of nematode attack. (I) Beltsville, Md.; Tifton, Ga.

Animals

Nonchemical control of mastitis. Studies on management methods which would reduce the need for chemicals in the treatment of mastitis of dairy cows have shown that sanitary practices have real importance in the control of these udder diseases. Also, first lactation cattle are particularly resistant to mastitis, suggesting that the tight teat sphincters and canals in these animals are important to preventing infection. Methodological studies indicate that there is no definite cell count level that will effectively separate infected from noninfected quarters. (I) Beltsville, Md.

House flies control by chemosterilant baits. In small scale field tests in cage-layer poultry houses, flies were reduced or eliminated by chemosterilant baits except where subject to reinfestation from nearby breeding areas. Further research is needed to evaluate the safety of chemosterilants and methods of using such materials. (I) Gainesville, Fla.

Intestinal Threadworm Immunity in Cattle. Studies have been conducted to determine whether it might be possible to protect cattle against the depredations of parasitism by immunizing them with nonpathogenic worms. Three species of Cooperia, intestinal worms, are common parasites of cattle. One, C. oncophora, is virtually nonpathogenic, whereas the other two, C. punctata and C. pectinata, are potential killers. Calves were immunized by oral inoculations with either C. oncophora or C. pectinata and subsequently challenged with infective larvae of the opposite species or of C. punctata. Calves immune to C. oncophora and challenged with C. pectinata had an average of 130 worms at necropsy whereas nonimmune controls had 34,000; calves immune to C. oncophora and challenged with C. punctata had 4,250 worms whereas controls had 28,000; calves immune to C. pectinata and challenged with C. oncophora had 41,850 worms whereas controls had 90; calves immune to C. pectinata and challenged with C. punctata had 21,300 worms whereas controls had 28,800. The results indicate that there is cross immunity in cattle between three closely related species of worms, and suggest the possibility of providing protection against pathogenic species by means of immunization with nonpathogenic species. (I) Beltsville, Md.

General aspects of research partially supported by Hatch and McIntyre - Stennis funds. Research has been conducted on the biological control of mosquitoes, biting flies, other insects, nematodes, and other internal parasites of animals and poultry. Predaceous aquatic insects that feed on mosquito larvae were collected in a number of habitats and are being evaluated for their influence on chironomid as well as mosquito larval populations. Thirteen species of mosquito have been found infected with one or more species of microparasites. In vitro cultivation of two new species of parasitic nematode infesting domestic animals was accomplished. A peptidase extract from the roundworm of swine was partially purified and used as a potential antigen in attempts to immunize pigs against the parasite. When pigs were challenged with infective eggs the treated ones had nearly a 50 percent decrease in the number of migrating larvae reaching

the lungs as compared with untreated control pigs. Other lines of non-pesticidal control of parasites of animals were investigated. (E) Agr. Exp. Stas. of: Calif., Conn., New Haven, Fla., Nebr., Nev., Miss., Mo., Mont., N. H., N. J., W. Va., Wis.

Field Crops

Cereal leaf beetle egg parasite. The myarid egg parasite, Anaphes sp., of the cereal leaf beetle is being reared in Indiana as well as in Michigan. Between time of receipt of stock from France in June 1965 and June 1966, 25 generations were reared in the laboratory. The species was released in both Indiana and Michigan. Subsequent to the releases parasitized cereal leaf beetle eggs were recovered at each release site. Laboratory colonies are being maintained at three laboratories and now include stock obtained originally from Italy, France, Germany and Yugoslavia. (E) Mich. State Univ., Purdue Univ.

Cereal leaf beetle parasites. Research studies to develop mass rearing and release techniques for parasites to be used in the control of the cereal leaf beetle were started. Field releases, involving approximately 5,000 adult egg parasites Anaphes, were made in Michigan. The recovery of parasites has been successful with approximately 30% of eggs examined being parasitized. (I) Lansing, Mich.

Cereal leaf beetle resistance. Eight thousand entries were evaluated for the cereal leaf beetle resistance in Michigan. Approximately 55 varieties of winter wheat and a comparable number of spring wheats exhibited resistant reactions. The most common type of resistance observed in the wheats was nonpreference of resistant varieties by the beetle for oviposition. Entries CI 6671, and 6469 were the most resistant barleys to the cereal leaf beetle. (I) Lansing, Mich.

Inert dust evaluated for control of insects in stored corn and wheat. In tests with corn in 500-bushel bins in Georgia, a silica aerogel dust gave protection against stored-grain insects comparable with that from malathion 32 months after treatment. The effectiveness of both materials decreased considerably between the 24 and 32 months. Malathion residues were 1.2 ppp.m. at 24 months and 0.9 p.p.m. at 32 months, indicating the treatment has reached the breaking point of protection. In field tests in Kansas, where thirty 3,250 bushel-bins of wheat were sampled regularly over a 30-month period, observations indicated that diatomaceous earth and silica aerogel wheat treatments were nearly as effective as malathion in preventing insect buildup in dry wheat. Observations also indicated that the inert dust treated wheat tended to retain moisture from leaks during snow and rain storms, causing spoilage and insect development in localized areas. (I) Tifton, Ga., and Manhattan, Kan.

Resistant Wheat Varieties Released. Twelve wheat varieties were released. In the group four have good resistance to stem rust, two to stripe rust, two to leaf rust, two to wheat stem sawfly, and one to hessian fly. Moro, a club wheat, has high stem rust resistance in all stages of growth and to all races of common and dwarf bunt. (I) Aberdeen, Idaho; Lafayette, Ind; Bozeman, Mont; Fargo, N. D.; College Station, S. D; College Station, Tex; Corvallis, Ore; Pullman, Wash.

Cercospora Foot Rot tolerance in Wheat. A surprisingly high number of wheat selections tested showed unexpected high levels of tolerance to Cercospora foot rot. (I) Pullman, Wash.

Wheat stem sawfly rust resistance. The first spring wheat variety with both sawfly and rust resistant characteristics has been developed and released in North Dakota. This variety, called Fortuna, has out-yielded and been heavier in test weight, than the sawfly resistant variety Chinook and Rescue, both of which do not have rust resistant characteristics. (I) Fargo, N. D.

Barley Stripe Mosaic - free barley seed. Methods have been developed for increasing and maintaining seed free from barley stripe mosaic viruses and this has reduced the losses due to this disease. They were high in 1951 to 1960 but in 1965, less than 2 percent of the commercial barley fields surveyed in North Dakota had plants with barley stripe mosaic. (I) Fargo, N. D.

Physical and cultural control of stored-rice insects. Increasing the intensity of infrared radiation applied to rice internally infested with immature stages of the rice weevil, lesser grain borer, and Angoumois grain moth caused a proportionate increase in insect mortality, even though the total dosage of radiation was held at the same level. Rice weevils and lesser grain borers showed a definite preference for feeding on certain varieties of rice in tests where the results were based on an evaluation of the amount of damage to kernels. (I) Fresno, Calif.

Corn Lines Resistant to Virus. Two inbred lines of corn were released which are resistant to the corn virus occurring in Tennessee. (I) Knoxville, Tenn.

Insect Resistance in Corn Lines. The corn inbred lines B59, B65, and B64 were released. B59 and B65 have moderate to good resistance to the first brood of the European corn borer. The inbred line B64 has a high level of tolerance to the western corn borer. (I) Ames, Iowa.

European corn borer sterilization. Research studies on the irradiation of diapausing corn borer larvae indicate that 4,000 or 5,000 roentgens will sterilize corn borer males and reduce female egg production and hatch to near zero. Irradiated larvae pupated normally and emerged as apparently normal moths. This is considered to be a breakthrough in sterilization techniques for Lepidoptera. (I) Ankeny, Iowa.

European corn borer control with *Bacillus thuringiensis*. *Bacillus thuringiensis* in capsule, granule and emulsifiable formulations gave excellent control of the borer. Laboratory studies with the bacterium showed that the spore and crystalline inclusion are necessary to kill borers. (I) Ankeny, Iowa.

Fall armyworm resistance in corn. Fifty-two corn lines were screened in the greenhouse for leaf damage by fall armyworm larvae. Inbreds, Zapalote Chico, Zapalote Grande, and Antiqua, 2-D, showed resistance. In general, sweet corn showed more resistance than dents but further tests are needed to confirm this. (I) Tifton, Ga.

Charcoal Rot of Sorghum. A contract with the University of Arizona provides for expanded research on developing and evaluating techniques to measure resistance to charcoal rot of sorghum. It has been established that for the development of the disease in the field, grain development in the milk to dough stage, daily maximum temperature should be above 35°C., and there should be a low moisture stress. Early types of sorghum are generally more susceptible than those with later maturities. (E) Univ. of Ariz.

Alfalfa aphid resistance. Good progress is being made in developing alfalfa varieties resistant to more than one insect. Seed of one synthetic variety with resistance to the pea aphid, spotted alfalfa aphid and bacterial wilt is presently being increased in Oregon. (E) Kan. Agr. Exp. Sta.

Alfalfa weevil bacterial disease. A bacterial disease was isolated from the alfalfa weevil in the fall of 1965. This isolate was highly pathogenic to larvae by injection and slowly pathogenic when larvae fed on contaminated foliage. Larvae exhibiting typical disease symptoms were commonly collected in the field throughout the spring. (I) Beltsville, Md.

Spring Burning Beneficial to Shinnery Oak Rangeland. Research over the past 5 years has shown that controlled burning of shinnery oak ranges not only increased yield but improved both the palatability and availability of the forage. In dry years, burning in April gave greatest benefits, while in wet years burning can be extended to mid-May. Increase in forage yield, in response to controlled spring burning, has ranged up to 500 lbs/acre. (I) Woodward, Okla.

Disease and Nematode Resistant Korean lespedeza. Yadkin, Korean lespedeza, has been released to growers. Yadkin is higher yielding in seed and forage, and later in maturity than Korean. It carries resistance to the tar spot fungus and to root-knot nematodes. (I) Raleigh, N. C.

Root Rot Resistant Birdsfoot trefoil. Foundation seed of Dawn birdsfoot trefoil was released to growers in 1966. Dawn is a long-lived pasture type, more resistant to root rot fungi than Empire. (I) Columbia, Mo.

First Lupine Variety Resistant to Diseases. Rancher blue lupine was released to growers in the fall of 1965. This is the first forage variety of blue

lupine that carries resistance to anthracnose and gray leafspot and is genetically marked for ease of identification. (I) Tifton, Ga.

Control of weeds in grass crops grown for seed production. German velvet-grass is a perennial weed troublesome in production of grasses for seed. It is difficult to control with selective herbicides. Research shows that brief exposure to temperatures of 20°F kills the over-wintering rhizomes. This finding indicates the practicality of using cultural methods for control of rhizomes combined with effective herbicides for control of plants from seed. (I) Corvallis, Ore.

Sorghum midge - free planting dates. Results of tests conducted over a period of three years have indicated that sorghum planted at the normal planting date, and blooming in late July or early August, will escape damage from the midge. The possibility of establishing a midge-free planting date for sorghums is being investigated. (I) Stillwater, Okla.

Soybean Germplasm Resistant to Nematodes. An advanced breeding line of soybeans (D63-7320) has been developed with good resistance to the soybean cyst nematode and root-knot nematodes. (I) Jackson, Tenn.

Resistance to Southern Corn Rootworm in Peanuts. Preliminary results in North Carolina indicate that both adults and larvae of southern corn rootworm show a preference for feeding on certain peanut genotypes when a choice is available under either field or laboratory conditions. Whether such a reaction can be considered a reliable indication of genetic resistance or susceptibility of the germ plasm to the insect is being investigated. The world collection of germ plasm is being screened for resistance suitable for use in breeding improved commercial peanut varieties with resistance to the rootworm. (I) Holland, Va. and (E) Georgia Agr. Exp Sta.

Inert dusts evaluated against stored-peanut insects. Intermediate-scale experiments showed that 4 inert dusts applied at 3 rates on farmers stock peanuts were not as effective as the standard malathion treatment after 9 and 12 months of storage. Under conditions of this test, the breakdown of effectiveness of the inert dusts occurred between the 6th and 9th months of storage. (I) Tifton, Ga.

Physical method for control of stored-peanut insects. Light trap tests in peanut warehouses showed that Indian-meal moths gave the greatest positive response to green light. Cigarette beetles and lesser grain borers responded in greater numbers to traps with ultraviolet sources. Light traps suspended horizontally in peanut warehouses captured greater numbers of adult moths than did traps suspended vertically. (I) Tifton, Ga.

Biological methods for control of stored-peanut insects. Indian-meal moth larvae from a corn mill were found infected with a crystal-forming bacterium resembling Bacillus thuringiensis. Indian-meal moth larvae from peanut warehouses were found infected with a granulosis virus, only recently found

in this moth in California. This is the first known appearance in peanut warehouses. Almond moth larvae from peanut warehouses were found infected with a polyhedrosis virus, the first known report from this species. Both viruses were highly infectious in laboratory feeding studies. The polyhedrosis virus was more host specific than was the granulosis virus. (I) Tifton, Ga., and Beltsville, Md.

Hermetic storage; stored-peanut insects. All red flour beetle adults in shelled and inshell peanuts stored in hermetically sealed 1-gallon bottles at 40°, 80°, and 100°F. were dead within 4 weeks. Trogoderma glabrum and rice weevil adults were exposed 3 and 7 days and T. glabrum larvae 7 and 14 days at 40°, 60°, 80°, and 100°F. to binary and ternary mixtures of nitrogen, oxygen, and carbon dioxide. All of the insects were killed within 7 days at 80°F. when exposed to the binary mixtures containing 0.5 percent or less of oxygen or to ternary mixtures containing 2 percent or less of oxygen and 93 percent or more of carbon dioxide. The T. glabrum and rice weevil adults were also killed within 3 days when the oxygen concentration was 13.5 percent or less and the carbon dioxide concentration 47.5 percent or more. One-day-old Indian-meal moth eggs were exposed for 7 and 14 days at 80°F. to binary and ternary mixtures of oxygen, nitrogen, and carbon dioxide. With the exception of the binary mixtures consisting of 10.5 percent of oxygen and 89.5 percent of nitrogen, two-thirds or more of the eggs were dead within 2 days after a 1-week exposure. Maximum mortality occurred in mixtures with 2.7 percent of oxygen or less. (I) Savannah, Ga.

Cotton square destruction. Work was continued on a flail machine for destroying fallen cotton squares in order to improve the pick-up efficiency. The mean pick-up efficiency for the season was 88.1%. 94.8% of the immature boll weevils in squares that passed through the machine were killed by the flail. Although the adult boll weevil population and number of punctured squares were higher in fields treated with the flail machine than in fields treated with recommended insecticides, in only one field did the egg punctured squares exceed the 10% recommended starting point for applying insecticides. (I) State College, Miss.

Boll weevil control by a protozoan. Effectiveness of Mattesia grandis, a protozoan, in boll weevil population suppression was tested in 1/16 acre field cages. The spores were applied in a formulation containing the feeding stimulant as either the water extract of squares or extracted from cottonseed oil. The disease held the adult population below that of the check, but of even greater importance was the prevention of the sharp population increase of the F₂ generation that occurred in the check. The damage to squares was reduced and the yield increased in the treated cages. (I) State College, Miss.

Boll weevil parasite. A colony of Bracon kirkpatricki adults was obtained from Kenya. More than 50,000 adults of this parasite have been reared on host third instar boll weevil larvae and field releases are planned. Total life cycle in this strain was almost one day longer than for B. mellitor. As in the native species, males are produced parthenogenetically. No evidence of interspecies mating was observed. (I) State College, Miss.

Boll weevil sterilization. In a large one-half-acre cage in Iguala, Mexico, apholate applied to cotton in a bait formulation with crude cottonseed oil as an attractant was as good or better than when applied in a wettable powder spray. (I) State College, Miss.

Bollworm control with a pathogen. In laboratory and field tests larval feeding stimulants applied with the Heliothis nuclear polyhedrosis virus increased its effectiveness in control of the bollworm. In field plot experiments the virus applied in a dust was more effective than in a spray. Dust applications equivalent to 100 virus-diseased larvae per acre gave control that compared favorably with a recommended insecticide. (I) Brownsville, Tex.

Effect of virus on bollworm. Studies in Texas indicated that there was more than an additive effect on bollworm larva mortality when the nuclear polyhedral and cytoplasmic viruses were used together. An added advantage for the use of the mixture would be the effectiveness of the cytoplasmic virus against other lepidopterous pests not affected by the polyhedral virus. (E) Tex. Agr. Exp. Sta.

Pink bollworm sex attractant. The recently synthesized pink bollworm sex lure, popylure, attracted males. Males released in 6x6x36-foot cages responded to traps baited with 1 µg of popylure per trap, which is equal to 1,000 female equivalents (FE) of natural lure. However, 2,000FE of propylure was required to compete with 24 FE of natural lure. Popylure was very short lived with 2,000 FE failing to trap males by the third night. Preliminary tests indicated that an inactive extract from female moths extended the effectiveness of popylure. (I) Brownsville, Tex.

Cotton fleahopper resistance. In field tests cotton strain 1514 and two improved strains of 1514, 321 OP and 370 OP, were equally resistant to cotton fleahoppers. (I) Waco, Tex.

Transfer of Root-knot Nematode Resistance into Cultivated Extra-long Staple Cotton, *G. barbadense*. Resistance to root-knot nematodes was discovered in a stock of *G. barbadense* var. darwinii several years ago. Genetic studies indicate that resistance is conditioned by at least two recessive genetic factors. The transfer of resistant factors to commercially acceptable Pima varieties is being accomplished by (1) backcrossing to Pima, (2) recovery of resistant progeny, and (3) repeating the process until resistance is combined with desirable agronomic and fiber properties. (I) Phoenix, Ariz.

Bridge-cross technique in tobacco breeding. Inability to hybridize the highly disease-resistant species *Nicotiana repanda* with tobacco has been overcome by a bridge-cross technique. *N. sylvestris* was employed as the intermediate or bridging parent by crossing it and backcrossing it to *N. repanda*. Later, a *sylvestris*-like plant with some *repanda* characteristics was crossed to tobacco. This technique should be useful in transferring new germplasm for resistance to the root knot nematode from *N. repanda* to tobacco. (I) Beltsville, Md.

Development of Basic Tobacco Breeding Stocks Resistant to Brown-spot. Brown-spot resistant flue-cured tobacco breeding lines developed from the variety Quin Diaz, a well-known source of resistance to the disease, have consistently exhibited a cigar flavor. The apparent linkage between brown-spot resistance and off flavor was broken in 1965 tests. One line, PD-657, out of 45 test-smoked, had a satisfactory cigarette flavor. This finding seems to establish a starting point for the development of brown spot resistant flue-cured tobacco varieties of acceptable smoke flavor. (I) Florence, S. C.

Integrated control of tobacco insects. An integrated control program reduced the number of insecticide applications required to control shade tobacco insects by 76%. Light traps were used in combination with a soil treatment of disulfoton, a systemic insecticide, and foliage treatments with Bacillus thuringiensis and nonpersistent pesticides such as azinphosmethyl or parathion. (I) Quincy, Fla.

Ecological method of control of cigarette beetle in stored tobacco. Living cigarette beetle larvae were found at depths of 4 to 20 inches of tobacco in heavily infested hogsheads held at 48°F. for more than 20 weeks. The study is to investigate the effect of low temperature on the cigarette beetle in the natural environment of the tobacco hogshead. The tobacco temperature ranged between 50 and 52°F. Numerous living larvae were present at the time of final inspection but the number of live insects was inversely proportional to the length of exposure. Living adults found in the later inspections are believed to be from pupae that transformed even at the low temperature of 50 to 52° F. Third and fourth instar larvae of the cigarette beetle to be used in low-temperature studies in the laboratory were preconditioned by gradual reduction of temperature from 80 to 60° F. over a 4-day period. During this time the larvae doubled their average weight. When the larvae were then held at 40° F. there was a continuing loss in weight and within three weeks there was heavy mortality. (I) Richmond, Va.

Green peach aphid parasite. The green peach aphid has a number of common parasites in Missouri, but the usual parasites of this aphid on tobacco seem to be absent in the southeastern United States. Greenhouse aphid colonies in Missouri were found to support large numbers of Aphidius matricariae, a parasite not usually found associated with the green peach aphid. Rearing of the parasite was initiated in the laboratory for possible introduction into Florida tobacco growing areas. Preliminary observations on rearing indicate that the parasite may have the potential of reducing populations of the aphid below economically important levels. (I) Columbia, Mo.

Tobacco budworm parasite. A culture of tachinid flies, Drino mundo, is being maintained in the laboratory, using budworm larvae as hosts. Field releases have not yet been made but are planned for the near future. Approximately 3,000 tobacco budworms 15 to 30 mm long collected from tobacco plants between July 26 and August 18 showed 30% parasitism by Cardiochiles nigriceps. (I) Oxford, N. C. and Quincy, Fla.

Tobacco hornworm control - light traps plus stalk destruction. Populations of tobacco hornworms remained below an economic level in a 314-square-mile tobacco growing area in North Carolina containing blacklight traps and where stalks had been destroyed after harvest. Significant increases in moth catch occurred when virgin females were placed in the vicinity of the traps. Traps have been installed on St. Croix, Virgin Islands, for studies of their effectiveness in suppressing the tobacco hornworm on the island. (I) Oxford, N. C.

Sugarcane Resistant to Virus Diseases and Borers. The resistance or susceptibility of sugarcane varieties to the sugarcane borer was determined from field observation. These varieties are being studied for characters related to resistance. Additional crosses have been made and the progenies planted. Characters such as distribution of fibrovascular bundles in the stalks, hardness of rind, fiber content, stalk, diameter, persistence of sheath, leaf surface and angle are being studied. (I) Canal Point, Fla. Houma, La.

Quick Shading and Dense Varieties of Sugarcane for Weed Control. Three hundred and fifty thousand seedlings were selected from 1,780,000 seed that came from 403 crosses of sugarcane breeding stocks and varieties. Selection is proceeding for quick shading, dense varieties that will reduce the need for herbicides. (I) Canal Point, Fla.

Screening Sugarbeet Breeding Stocks for Curly Top Resistance. Breeding for resistance to the virus has provided protection against serious losses from curly top and eliminated the need for applications of insecticides to the sugarbeet. The use of pesticides has been eliminated except in mesa areas which are the natural habitat of the vector and sources of primary inoculum. (I) Logan, Utah.

Breeding Sugarbeets resistant to Root Diseases and Leafspot. Obtaining and maintaining stands of sugarbeet have been major problems of production in the Great Lakes Region. Using Aphanomyces cochlioides as the test organism, resistance to pathogens causing black root and root rot has been established in a broad span of sugarbeet breeding material. The level of resistance attained makes untenable past recommendations of fungicidal dressings to seed for the control of black root of sugarbeet. (I) East Lansing, Mich.

Breeding Hops for Resistance to Arthropods. A screening program for arthropod resistance of the various genetic varieties of hops was conducted under insectory conditions. Fecundity of both the hop aphid and two-spotted spider mite was reduced on a number of varieties compared with the Fuggle check variety. Two varieties showed a reduction in the 50 to 59 percent resistant level to both pests. One variety had an 80 percent reduction in aphid fecundity and 58 percent reduction in mite fecundity. These preliminary data indicate the possibility of breeding hop varieties with genetic resistance to the hop aphid and two-spotted spider mite. (I) Corvallis, Ore.

General aspects of research partially supported by Hatch and McIntyre - Stennis funds. Progress is being made in the breeding and selection of field crop varieties that are resistant to insect pests and diseases and in determining the chemical as well as the genetic basis of resistance. Both grain and forage crops are being improved. Other lines of nonpesticidal control of pests of field crops are showing promise. (E) Agr. Exp. Stas. of: Ala., Ariz., Ark., California, Berkeley, Davis, Colo., Ga., Ida., Ill., Ind., Iowa, Kan., Ky., La., Md., Minn., Miss., Mo., Mont., Nebr., Nev., N. J., N. M., N. Y., Ithaca, N. C., N. D., Ohio, Okla., Ore., Pa., P. R., R. I., S. C., S. D., Tenn., Tex., Utah, Va., Wash.

Horticultural Crops

Breeding Potatoes Resistant to Ring Rot. In cooperation with the Maine Agricultural Experiment Station, 19 out of 344 seedlings tested for ring rot resistance were found free of tuber symptoms. Seedlings of three selections included in the resistant group are now on increase for commercial evaluation. (I) Presque Isle, Maine.

Aphid control on potatoes. Approximately 3,000 *Coccinella septempunctata* larvae have been produced per week for release for aphid control in potato experimental plots. Studies have shown that egg production was limited due to diapause of the predaceous beetles. (E) Maine Agr. Exp. Sta.

Parasite diet preference. Studies showed that when predators were introduced into mixed populations of potato and green peach aphids infesting potatoes, chrysopid larvae fed mainly on the latter and coccinellids on the former. (I) Presque Isle, Maine.

Hornworm damage to tomatoes. For the second consecutive year blacklight insect traps significantly reduced hornworm damage to tomatoes in field-scale plantings. Hornworm infestation near the traps was substantially reduced and in a field with tomato plants ranging up to 532 feet from a light traps 12% of the plants were infested on August 10, 1965, as compared with 54% in an unprotected field. (I) Lafayette, Ind., and (E) Purdue Agr. Exp. Sta.

World Bean Collection. The second part of a three-phase exploration to the centers of origin of cultivated beans (*Phaseolus vulgaris*) in Mexico and Central America was completed. Over 1300 collections, representing highly local types from remote villages and farms, were brought in and are now being evaluated for resistance to bean root rot (*Fusarium*), bacterial blights, and viruses. (I) Beltsville, Md.

Downy Mildew-resistant Varieties of Lima Beans. The first downy mildew-resistant, green-seeded Fordhook, U.S. 861, was released to the seed trade early in 1966. Several very productive Jackson Wonder types, also resistant to the two strains of the organism, are being increased for commercial trials. Resistant white-seeded Fordhook, U.S. 761, again showed promise in

1965 and will be tested commercially in 1966. It is 4 to 5 days earlier than Fordhook 242 and is a smaller plant. (I) Beltsville, Md.

Pea aphid parasites. Approximately 100 million parasitic wasps (Aphidius pulcher Baker) were reared on pea aphids infesting alfalfa in heated plastic covered field cages early in the spring. When released, the parasites invaded about 15,000 acres of alfalfa, overflowing the native aphid population and delaying migration of aphids to pea fields where they are vectors of pea enation virus. (I) Yakima, Wash.

Nature of Resistance to Stem Nematode. Plant growth regulators, 2,4-D, dinitrophenol and amiben, did not alter resistance or susceptibility of peas to the stem nematode. (E) Univ. of Md.

New Race of Lettuce Mildew. In Texas, the single most outstanding event of the lettuce season was the appearance of what is believed to be a new biological race of the downy mildew organism. All varieties and lines previously immune to downy mildew were fully susceptible or susceptible in some degree to the new race of the organism. Field observations indicate there is a wide range of susceptibility to the new race of mildew. Valverde, Valmaine and 50588-M displayed the most resistance, while Calmar and M-14 were most susceptible. (I) La Jolla and Brawley, Calif.

Cabbage looper parasites. Voria ruralis was responsible for a high percentage of parasitism of cabbage looper larvae collected in the field near Mesa, Arizona. In field cages, 57% of 300 looper larvae were parasitized when 175 pairs of flies were released in the cage. This amounted to only one parasitized larva per female Voria. (I) Mesa, Ariz.

Resistance to Downy Mildew in Muskmelons. The new variety Perlita, a product of cooperative effort of the Texas Agricultural Experiment Station with the U. S. Department of Agriculture, has proved its usefulness to commercial growers in the Lower Rio Grande Valley. Perlita was the only variety to produce a marketable crop in this area in the spring of 1966 due to its relative resistance to downy mildew. (I) Brawley, Calif.

Cucumber beetles. A trial of the effectiveness of blacklight traps in protecting field-scale cucumber plantings from wilt disease transmission by cucumber beetles has been initiated. This is an expansion from results in small plots which showed light traps to be as effective as recommended insecticide treatment. Mid-season results are encouraging, but reflect serious drought injury. (I) Lafayette, Ind.; (E) Purdue Agr. Exp. Sta., and H. J. Heinz Co.

Resistance and Nature of Resistance of Cucurbits and Other Vegetables to Nematodes. Cucumis species with resistance to the rootknot nematode are being used in attempted crosses with C. melo and C. sativus. No F₁ plants from crosses between C. melo and other species have been obtained thus far. A successful cross between C. hardwickii and C. sativus has been made and the fertile hybrid may provide a bridge between C. sativus and Cucumis species with nematode resistance. (I) Charleston, S. C.

Multiple Disease and Nematode Resistant Peach Rootstock. Nematode-resistant Nemaguard peach rootstock appeared to have resistance to pythiaceous root and crown rotting fungi. (I) Clemson, S. C.

Nature of Disease Resistance to Apple Scab. Resistance gene relationship research indicates that there are 4 distinct gene pools responsible for scab resistance. Promising scab-resistant selections have been widely distributed for additional evaluation. (E) Ind. Agr. Exp. Sta.

Scald control by heat treatments. The use of postharvest chemical treatments (diphenylamine and ethoxyquin) for control of apple scald is now general in all USA commercial apple areas. However, certain European markets do not approve the addition of these chemicals. Research has shown promise for hot water dips at harvest time as a substitute for chemical scald inhibitors. Scald on Stayman apples has been well controlled during storage by a 30-second dip in water at 130° F. Response in other varieties has not been so favorable but efforts are continuing to determine optimum temperatures and exposures for each commercial variety. (I) Beltsville, Md.

Screening Method for Root Rot-resistant Citrus Rootstocks. The aerated water bath technique for screening has been improved by using a reduced amount of inoculum and by selecting cultures of *Phytophthora* that are more moderate in their pathogenicity. Good results are also obtained by growing plants in naturally-infested field soil in tanks in the greenhouses. The tristeza-tolerant Australian sour orange shows a high degree of *Phytophthora* tolerance. (I) Indio, Calif.

Evaluating Citrus for Root Rot and Burrowing Nematode Resistance. Seedling progeny of nematode-resistant and tolerant varieties show various degrees of tolerance. The most resistant selection was an Argentine trifoliate orange rootstock. The losses of citrus replants are the least on trees on Carrizo citrange and excessive for trees on rootstock varieties Ridge, Milano and Estes. (I) Orlando, Fla.

Breeding Disease Resistant Strawberries. Disease resistance is the major objective in the breeding research at Beltsville. Six advanced selections appear promising and have been propagated and distributed for further evaluation to cooperating growers and State experiment stations. (I) Beltsville, Md.

Breeding Elms Resistant to Dutch Elm Disease and Phloem Necrosis. A tetraploid *Ulmus pumila* was produced by treatment of very young seedlings with colchicine. *U. pumila* is highly resistant to Dutch elm disease. It has 28 chromosomes and *U. americana* has 56. Despite thousands of attempts to hybridize the two species, no hybrids have been produced over a 25-year period. The new tetraploid *U. pumila* may cross with *U. americana*. (I) Delaware, Ohio.

Indexing Plants for Chrysanthemum Stunt Virus. A rapid method has been developed for indexing plants for chrysanthemum stunt virus. Local starch lesions of chrysanthemum stunt virus can be detected on inoculated leaves of

florists' cineraria, Senecio cruentus, 15 to 20 days after inoculation. Light and temperature conditions for seedling development and maturity of the plant are important factors which influence host susceptibility. (I) Beltsville, Md.

Heated air for disease control. Further research has shown that commodities not adapted to hot water treatment respond well to treatment with heated air at near-saturated humidities. Strawberries, red raspberries, blueberries, and fresh figs have developed much less decay during simulated marketing periods when exposed for 1/2 hour at 110° F. with 90 to 99 percent relative humidity than when untreated or treated with certain fungicides. The vapor heat treatment is not yet in commercial use but development of methods for adaptation is in progress. (I) Beltsville, Md. and Fresno, Calif.

Insect-resistant packages for dried fruits. A laminate of kraft paper, 1-mil polyethylene, and 0.00035-in. foil resisted insect penetration for 6 months in a test of packaging materials for dried fruit. In another test a 3-mil polycarbonate film was effective for 5 months, while a 1-mil film was slightly less effective. Other less effective materials were 1-mil polyethylene, and laminates of kraft paper with 1/2-mil polyurethane or 1-mil polyethylene, nylon, or polycarbonate. All common types of fig packages had some insect invasion within 1 month in the infestation room except a plastic cup with polyethylene cover. (I) Fresno, Calif.

General aspects of research partially supported by Hatch and McIntyre - Stennis funds. Good progress has been made in the biological control of insect and mite pests and plant diseases including nematodes through breeding for plant resistance to these pests in various horticultural crops. Biological control of insects attacking horticultural crops with pathogens, parasites and predators was further developed. The study of chemosterilants, sex attractants and baits for the control of insect pests of horticultural crops has been promising. (E) Agr. Exp. Stas. of: Ala., Ariz., Ark., Calif., Berkeley, Davis, Riverside, Colo., Conn., New Haven, Del., Ga., Haw., Ida., Ill., Ind., Kan., Ky., La., Me., Md., Mass., Minn., Miss., N. H., N. J., N. Mex., N. Y., Ithaca, Geneva, N. C., N. Dak., Ohio, Ore., Pa., P. R., S. C., S. Dak., Tex., Utah, Va., Vt., Wisc.

Forests

Antibacterial substances in tree foliage. The foliage of some trees contains substances that are toxic to certain insect pathogens. As an example material in Douglas-fir foliage inhibits the growth of Bacillus thuringiensis, an important commercially produced biological insecticide. Preliminary studies indicate that it may be possible to increase the usefulness of B. thuringiensis by developing strains that are resistant to the antibacterial substances in the foliage. So far some resistance has been developed in strains of B. thuringiensis grown on material prepared from Douglas-fir foliage. (I) Corvallis, Ore.

Life history of Douglas-fir root pathogen. Studies of the physiology and life history of Poria weirii, a serious root pathogen of Douglas-fir, reveal that the fungus survives best in wood residues. Where antagonistic microorganisms are present colonies of P. weirii in buried wood are stimulated to enclose themselves in zones of dense tissue that may serve as defensive barriers against antagonists and thus decrease the possibilities for antibiotic control. (I) Corvallis, Ore.

Fungus infection survival. Inoculation and isolation data obtained during a study of colonization of slash pine stumps by Fomes annosus indicate that the fungus infection and survival is less during the spring and summer months (March-September) when stump surface temperatures reached 40° C. or above for sustained periods than during the fall and winter. Potential losses from this serious root pathogen should be substantially reduced by thinning during the summer months only. (I) Athens, Ga.

Mycorrhizae as producers of antibiotics. Several mycorrhizal fungi have been demonstrated to have potential as producers of economically useful antibiotics. One has shown marked ability to suppress a bacterium belonging to the staphylococcus group. (I) Durham, N. C.

Root protection by fungus. The root protecting function of one mycorrhizal fungus has been confirmed. Douglas-fir seedlings on which mycorrhizae were formed with Corticium bicolor suffered no root damage when subsequently inoculated with a root-killing Pythium species. Seedlings grown under identical circumstances except for omission of the mycorrhizal Corticium suffered loss of about one-third of their root system by Pythium root rot. (I) Corvallis, Ore.

Control through male sterilization. The effectiveness of the sterile male control technique depends on the success of the sterilizing treatment and the ability of the sterilized male moths to compete with wild, untreated males in nature. This means that the sterilization must be accomplished without injury to the male moths which would adversely affect their ability to mate successfully. In studies on the gypsy moth, it was found that although the germ cells are more susceptible to ionizing radiation damage from the larval period, other tissue cells of the larva are also more susceptible to damage; adults developing from treated larvae were either not sterile, or if sterile were so crippled as to be ineffective. Sterilization treatments therefore must be directed against the pupae, in which stage the somatic tissues are much more resistant to radiation injury. (I) New Haven, Conn.

Birds as insect predators. Woodpeckers and other birds are generally recognized as important predators of insects but the degree of their importance is often difficult to determine. In California the black-backed, three-toed woodpecker was demonstrated to be an important predator on the wood boring insect Monochamus oregonensis. It is likely that additional attention will be given this and other species of birds as biological control assumes a more active role in regulation of forest insects. (I) Berkeley, Calif.

Blister rust resistance in western white pine. A long-range, applied research study to provide blister rust resistant western white pine seedlings as seed orchard foundation stock has entered its final phases. Semi-resistant, second generation stock should be available for field planting for 1985. (I) Moscow, Idaho.

Blister rust fungus resistance. Fungal penetration of needles of eastern white pine through stomates and not by direct penetration of the needle surface as sometimes suggested clearly indicates that resistance to the blister rust fungus is not due to either the leaf cuticle or the epidermis serving as a mechanical barrier to infection. (E) Univ. of Wis.

Canker resistance in aspen. Accumulated data suggest a possible genetic variation within the population, Hypoxylon pruinaum, the fungus causing Hypoxylon canker of aspen. Samples from widely separated areas are being compared in vivo and vitro in an effort to determine if differences do exist. Such information would be important in developing aspen resistant to this disease. (I) St. Paul, Minn.

Littleleaf resistance test. By growing shortleaf pine seedlings aseptically in large test tubes, it is possible to demonstrate in certain controlled-pollination progeny an apparent resistance to root infection by Phytophthora cinnamomi. The method provides a relatively quick test for identifying progeny with the greatest potential for resistance to the littleleaf disease. (I) Athens, Ga.

Needle cast fungus resistance. Twenty-nine seed sources of jack pine are found to differ in susceptibility to the needle cast fungus (Hypodermella ampla). At the end of the tenth growing season the least susceptible source, northeastern Minnesota, had only about 25 percent infection compared with 95 percent for trees from the Lower Michigan source. Since these differences remain constant from year to year and from environment to environment, they are considered to have a direct genetic basis. From these provenance tests selected trees will provide breeding material for geneticists to develop strains of jack pine resistant to the needle cast fungus. (I) Rhinelander, Wisc.

Purple mold fungus for control of blister rust. A major investigation of the purple mold fungus is underway in an effort to determine its real potential for biological control of the white pine blister rust fungus in the West. (I) Moscow, Idaho.

Root rot in forest soils. An investigation of six forest-meadow combinations in the Sierra Nevada revealed the presence of Fusarium spp. in the meadow soils and an absence of all Fusaria except F. roseum in the immediately adjacent forest soils. The biological interactions relating to the absence of common disease-producing Fusaria from forest soils are being studied. (I) Berkeley, Calif.

Southern fusiform rust resistance. Hybrids of loblolly and shortleaf pine are apparently resistant to southern fusiform rust, a serious disease that attacks loblolly pine. A major problem is to identify these hybrids in natural stands. Intensive studies of natural hybrids and hybrids of known parentage revealed ways to use combinations of vegetative characters to separate hybrids from parents in natural stands. This knowledge provides an effective way to identify and select from natural stands hybrids that can be used in breeding for strains resistant to fusiform rust. (I) Gulfport, Miss.

Predator control of balsam woolly aphid. For several years Old World insect predators have been imported for control of the balsam woolly aphid. Some of these are now firmly established; however at this point it appears problematical as to whether predators alone can bring populations down within tolerable limits. Additional introductions are being made. (I) Portland, Ore., and Asheville, N. C.

Bark beetle control with plastic sheeting. Slash from logging, pole line clearings, road rights-of-way or natural disturbances in forest stands are usually quickly infested by several species of ips engravers. At times, large populations of the beetles emerge from the slash and attack and kill healthy trees. Recent tests have shown that ips broods in slash can be readily controlled by encompassing the slash piles in plastic sheeting. Solar heat generated under the plastic covering exceeds 120° F., a temperature lethal to the beetles. (I) Albuquerque, N. M.

Burning to control cone beetles. One approach to controlling the red pine cone beetle is through the use of fire. Adult beetles hibernate on the forest floor inside buds and tips that break off when the beetles enter them in late summer after having developed in the cones. This makes the beetle population highly vulnerable to fire treatment during the hibernation period, and light burning is completely effective in destroying hibernating beetles. (I) St. Paul, Minn.

Biological control of elm bark beetles. Biological control is potentially a highly useful approach in control of the smaller European elm bark beetle, vector of the Dutch elm disease. A European insect parasite of the beetle has recently been introduced into North America and appears to be well established in several locations. Further introductions are planned. (I) Delaware, Ohio.

Smaller European elm bark beetle parasite. Dendrosoter protuberans, the principal parasite of the smaller European elm bark beetle was sent from France to the United States where a colony was established. Releases have been made in Ohio, Michigan, Missouri, and Maine. The parasite successfully survived the winter at Delaware, Ohio, as immature stages in elm billets even exposed in a woodlot. (I) Paris, France; Delaware, Ohio; East Lansing, Mich. (Mich. Dept. Agr. cooperating).

White pine weevil resistance. A year ago research determined that resistance of white pines to this insect is genetically controlled. New research results are now providing more efficient selection and testing criteria. At the site of natural injuries such as those caused by the white-pine weevil, a compound, leucocyanidin, accumulates and seems to be associated with resistance to insect entry. In other studies, it was found that many weevil-resistant trees form resins that did not crystallize during weevil attacks. These results provide promising leads for developing reliable criteria for selection of weevil-resistant individuals in the tree-breeding program. (I) Durham, N. H.

Virus diseases for control of Gypsy Moth. Disease, particularly a virus, causes significant natural population reductions in the gypsy moth as moth population density increases. The organism that causes these declines, a nuclear polyhedral virus, was used in an attempt to initiate a population decline. Although the dosage used was high and the treated area small, population reduction to acceptable levels indicates the potential of this organism for control of the gypsy moth. This approach is particularly important in light of the need for safe alternatives for chemical insecticides for control of forest pests. (I) New Haven, Conn.

General aspects of research partially supported by Hatch and McIntire - Stennis funds. The biology and ecology of the parasites of the Nantucket Pine Tip Moth have been studied. Research was initiated on diseases in eggs and larvae of gypsy moth. Boric acid was shown to increase the toxicity of Bacillus thuringiensis. Early foliating forest trees provide food for the earliest hatching forest tent caterpillar larvae which are inherently large, highly fecund, voracious migratory pests. In the absence of early foliating trees, these individuals starve and only later hatching genotypes survive which are mainly small, low fecund, light feeding, nonmigratory, generally inconsequential individuals. This shows that temporal escape is a potential source of pest resistance. Progress was made in other nonpesticidal control of forest pests. (E) Agr. Exp. Stas. of: Ala., Conn., Iowa, Wis.

TARGET III

TO DEVELOP SAFER AND MORE EFFECTIVE PESTICIDE USE PATTERNS,
FORMULATIONS, AND METHODS OF APPLICATION; AND IMPROVED
METHODS FOR DETECTING, MEASURING AND ELIMINATING OR
MINIMIZING PESTICIDE RESIDUES IN PLANTS, ANIMALS
AND THEIR PRODUCTS, AND IN THE ENVIRONMENT

General

Protection of honey bees. Research has provided new information on methods of protecting honey bee colonies from pesticide damage by flight restriction and time of application of pesticides. (I) Tucson, Ariz.

Discovery of a Naturally Occurring Abscission Retardant. Evidence has been obtained of the existence of a naturally occurring component of cotton plants which acts as an abscission retardant. This substance possibly represents a new type of plant growth regulator. Its isolation, purification, and chemical identity are the immediate objectives of the present research effort. (I) Davis, Calif.

Experimental low-toxicity compounds for mothproofing. Of 29 candidate compounds tested, five were found promising: Shell SD 8211, BAY 45515, BAY 58733, BAY 69047, and BAY 77488. BAY 77488 was found particularly promising because of its extremely low mammalian toxicity, 8,000 to 10,000 mg./kg. oral LD₅₀ for rats, and its effectiveness at very low concentrations. A calculated deposit of 0.0025 percent by weight of the cloth protected the fabric against damage by the larvae of the black carpet beetle, and a calculated deposit of 0.005 percent satisfactorily protected the cloth after three drycleanings. BAY 77488 produced some yellowing when applied to undyed test fabric but there was no visible staining on dyed cloth. A closely related compound, more stable and less staining, is being investigated. Poly-substituted nitrogen compounds (Polysubs) continue to appear promising after application studies conducted in home-type washing machines. The treatments were very effective although there were indications of uneven distribution of the compound on the cloth. (I) Savannah, Ga.

Screening of new herbicide. The vast potential of the chemical industry can be used to the fullest advantage by close cooperation with industry. More than 30 new potentially herbicidal chemicals from industry were studied in greenhouse and field experiments in a search for herbicides that combine improved performance, lower mammalian toxicity, and reduced residues in soils and crops. Several of the chemicals studied appear promising and merit advanced field evaluation. (I) Beltsville, Md.

Dichlorvos vapor is outstanding for control of Drosophila. Daily application of dichlorvos vapor gives excellent control of Drosophila flies in wine cellars, without presenting any residue problems. Analysis of air samples showed that workers could reenter the treated area 1 hour after application was completed. Processors claim this method is the first good control procedure they have ever had for control of these insects. (I) Fresno, Calif.

Fumigants for stored-product insects. In the preliminary laboratory evaluation of 26 candidate fumigants, tetrachlorocyclopropene and Virginia-Carolina 3-668 were found particularly promising. Both materials were more toxic to test insects than methyl bromide. Tetrachlorocyclopropene showed excellent penetrating qualities, but V-C 3-668 does not appear to be a good penetrant. (I) Savannah, Ga.

Control of Pondweeds by Herbicides. Six applications of acrolein at intervals of 3 to 4 weeks in 1965 controlled pondweeds for 10 to 20 miles from the point of application in a canal. Control was still adequate from 20 to 50 miles downstream. In addition, pondweeds in many of the branch laterals were adequately suppressed, particularly in those within 20 miles below the point of introduction. The concentration and total quantity of acrolein required for pondweed control were much less than in previously used methods of application. (I) Prosser, Wash.

Loss of parasites and predators by aerial drift. Studies showed that heavy deposits from airplane applications of methyl parathion occurred 400 to 800 feet from the flight line. Bioassay tests showed that these drifts caused high mortality of both parasites and predators of the brown soft scale. (I) Weslaco, Tex.

Low Volume Application of Defoliant and Desiccants. Preliminary results indicate that defoliant and desiccant concentrates may be applied directly to cotton at rates ranging in the order of one quart to one gallon per acre or less and effectively induce the required levels of leaf removal. Successful use of these methods in current farming practices would represent a considerable saving in application costs. Continued evaluation of the utility of these newly developed methods is planned. (I) Stoneville, Miss. and Shafter, Calif.

Soil Fungicide Applications. Chemicals were applied to the soil, in cooperation with the Ohio Center, on sugar beets and on a number of vegetables, in order to develop methods and equipment for more effective control of soil pests. Stands of sugar beets were increased over 80% above the average check stand by use of several chemicals. Two of several soil

treatments for control of *Verticillium* wilt of vegetables gave a substantial increase in yields of muskmelon, potatoes, okra, tomatoes, peppers, and eggplant. A series of vegetable plots which has received the same soil treatment for nine years shows bromine injury from two compounds which have given the best control of the root-knot nematode. (I) Wooster, Ohio.

Soil insecticide applications. In cooperation with the Ohio Center, radishes and turnips were planted with an initial application of 1 lb. actual insecticide per acre in the seed row. Fourteen different insecticide treatments were made. Seedlings were later given a drench spray of the same insecticide on a 2-inch width in the row at the same dosage rate. Satisfactory commercial control of cabbage maggots was obtained on these vegetables with four of the insecticides, without any evidence of phytotoxicity. Four of the treatments also reduced the turnip aphid infestations to a very low population. (I) Wooster, Ohio.

Ultra Low Volume Pesticide Equipment. Evaluation of new equipment, modification of existing insecticidal apparatus and the development of entirely new devices for applying pesticides safely and effectively are being continued. (I) Beltsville, Md.; Forest Grove, Ore; Weslaco, Tex.

Spray nozzle testing. Tests of various commercial spray nozzles were made to determine their suitability for operational aerial spray applications on several types of aircraft. It was found that conventional, commercially available nozzles produce droplets of 100-150 microns mass medium diameter. Testing will be continued in an attempt to fine or develop nozzles that will produce droplets in the 1-50 micron mass diameter range. The smaller droplet sizes are required to apply effective dosages of the ultra low-volume insecticides. (I) Missoula, Mont.

Pesticide derivatives in analysis. One of the more useful and sensitive methods for analysis of pesticides and their metabolites is gas chromatography. Unfortunately, not all pesticides, or their breakdown products, are sufficiently volatile to be analyzed by this method. However, it has been found that it is possible to use this method by forming tetramethylsilyl derivatives of pesticides or metabolites containing certain structural derivatives. (I) Fargo, N. D.

Analysis of chemosterilants. Gas-liquid chromatographic procedures have been developed for the analysis of the chemosterilants tepa, metepa, methiotepa, hempa, and apholate. The method employs a flame photometric detector and is sensitive to about 0.1 nanogram. When the procedure was used to recover tepa from adult fall armyworms, no interference was encountered. The ability to detect these chemosterilants in such small amounts enables the working out of conditions under which large scale field tests may be conducted safely. (I) Tifton, Ga.

Sorption and desorption of fumigants. The experimental fumigation chamber being designed and built specifically to study sorption and desorption of fumigants by various agricultural commodities as influenced by temperature,

Moisture, and exposure time is now being shop tested. Shipment to and installation at the Savannah laboratory is expected early in FY 1967.
(E) Vacudyne Corp.

Detection of pesticide residues in poultry meat, eggs, and dairy products. An improved technique for thin-layer chromatography was developed which incorporated silver nitrate in the plate as a chromogenic agent plus a small amount of oxidized fat to suppress interference from fat in the samples. The method will easily detect 0.01 g of the most common chlorinated insecticides. (I) Beltsville, Md.

Determining Picloram Residues in the Soil. A method was developed using a gas chromatograph equipped with an electron capture detector to determine soil residues of picloram which shows promise for control of brush on grazing lands. After a year, no detectable residues were present in the top 24 inches of soil in areas treated with rates up to 8 pounds per acre. Application of these data to other situations should recognize three points: up to 90 percent of the picloram was intercepted by foliage of brush infesting the areas; the soil was of light texture and received a total of about 30 inches of rain; and the soil was sampled to a depth of only 24 inches. (I) College Station, Tex.

General aspects of research partially supported by Hatch and McIntyre - Stennis funds. The use and application of conventional insecticides, fungicides, nematocides, herbicides and other pesticides has been improved. Methods of improving the determination of pesticide residues have been studied for use on various agricultural products. Combinations of pesticides and nonpesticidal methods of pest control are being developed. The effects of pesticides on the physiology of plants were studied. Other methods of improving the effectiveness of conventional pesticides and reducing environmental hazards of conventional pesticides were studied. (E) Agr. Exp. Stas. of: Ala., Ark., Ariz., Calif., Davis, Los Angeles, Riverside, Conn., New Haven, Fla., Ga., H.I., Ida., Ill., Ind., Iowa, Kan., La., Me., Md., Mass., Mich., Miss., Mo., Mont., Nebr., Nev., N. H., N. J., N. Y., Geneva, Ithaca, N. C., N. Dak., Okla., Ohio, Ore., Pa., P. R., R. I., S. C., S. Dak., Tenn., Tex., Utah, Vt., Va., Wash., Wis.

Animals

Hair loss from cattle - insecticide loss. A study was begun to determine the significance of hair loss from cattle as a factor contributing to the deterioration of insecticide treatments. Initial work has indicated that hair loss may not be significant from this standpoint. (I) Kerrville, Tex.

Daily activity pattern of insects. Preliminary work on an instrumentation system for detecting and evaluating the responses of stable flies, horn flies, and face flies to various physical and chemical stimuli has indicated that it is possible to obtain a continuous flight activity record of these

insects. One objective of this study is to determine the daily activity patterns of the insects and thereby determine the best time for insecticide application. Another objective is its use for screening chemical stimuli which may later be used in application techniques. (I) Kerrville, Tex.

Cattle Sprayer Design. Studies were conducted to determine the design criteria for both low-volume (100 ml) and ultra low-volume (1 ml) automatic sprayers for application of insecticides to dairy animals as a means of reducing the residue in the milk of these animals. The low volume sprayer is energized by an electric air compressor and applies 100 ml of a .1% Ciodrin (alpha-methylbenzyl 3-hydroxycrotonate dimethyl phosphate) solution per application. In field tests on a 300-cow dairy herd, the design has proved to be rugged, dependable, and effective. The ultra low-volume sprayer applies 1 ml of a 10% Ciodrin solution per application. It is a self contained unit energized by compressed air. Laboratory and field tests have shown that one treatment per day applied to the withers of the animal with this unit will control the horn fly on cattle. (I) Kerrville, Tex.

Cattle Louse Control. All motile forms of the short-nosed cattle louse were destroyed on similar louse-carrier hosts by a single pour-on application of famphur at a dose of 210 mg/kg, but famphur at the rate of 105 mg/kg and DDVP at the rate of 5 mg/kg failed to eliminate heavy infestations. (I) Albuquerque, N. M.

Treatment for Cattle Louse. Eradication of the short-nosed cattle louse (Haematopinus eurysternus) from heavily infested hosts was accomplished by daily doses of 2.5 mg/kg of famphur (Famophos) administered as a feed additive for 30 days. (I) Albuquerque, N. M.

Horn Fly Control. Studies were conducted comparing the effectiveness of low-volume (50 ml) and ultra-low (1 ml) volume spray applications for horn fly control on cattle. The low volume spray of 50 ml of a .25% ronnel (O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate) solution per treatment was applied through eight nozzles. The ultra-low-volume spray of 1 ml of a 10% ronnel treatment was applied through one nozzle. Both treatments controlled the horn fly with a 90% or higher mortality in a 24-hour post-treatment test. The ultra low-volume spray applied to the withers of the animals once per day appears most promising as a means of reducing the possibility of pesticide residues occurring in milk and meat. (I) Kerrville, Tex.

Spinose Ear Tick Control. Ciodrin is eminently capable of destroying infestations of the spinose ear tick within the ears of cattle and sheep, and effectively retards the reentry of larval ticks. (I) Albuquerque, N. M.

Feed Antioxidant inhibits nematode Larval Development. The antioxidant (Santoquin, Ethoxyquin, or E.M.Q.) used in commercial feeds had an inhibitory effect on nematode larval development in calf feces. Increasingly fewer nematode larvae were recovered from fecal cultures as the quantity of E.M.Q.

fed to infected calves was increased from the amount commonly used as a preservative (1/4 lb./Ton) up to 100 times (100x) that amount. In general, this was true in the case of Cooperia pectinata, C. punctata, Trichostrongylus colubriformis, T. axei, Ostertagia ostertagi, and Oesophagostomum radiatum. There was a statistically significant reduction in the numbers of infective larvae recovered from cultures made from feces from calves harboring infections with either T. axei or C. pectinata when varying amounts of an antioxidant, E.M.Q. were added to the cultures. Similar reductions were observed when E.M.Q. was added to cultures made from feces from a calf with a mixed natural infection. (I) Auburn, Ala. and Experiment, Ga.

Drug Resistance in Poultry Coccidiosis. Tolerance for specific coccidiostats was experimentally induced in strains of Eimeria tenella. Subsequently, these resistant strains were serially propagated in groups of chickens fed other coccidiostats to which the experimental strains were not cross resistant. In general, these strains developed a resistance to the other coccidiostats more rapidly than did strains that had no prior experience with drugs, and more rapidly than the experimental strains had acquired their initial resistance. (I) Beltsville, Md.

Treatment for Poultry Intestinal Threadworm. The intestinal threadworm, Capillaria obsignata, causes weight loss, lowered egg production, and death in chickens, turkeys, peafowl, and pigeons that become heavily infected with the parasite. Until recently, control efforts with anthelmintics have been rather unsuccessful. Tests were made with methyridine [2-(beta-methoxyethyl) pyridine] to establish the safety and anthelmintic efficacy of this recently discovered systemic drug against naturally acquired infections of C. obsignata in wild pigeons. Single subcutaneous injections containing 35 mg of methyridine removed 99 percent of 1,693 threadworms from 12 birds, and a 45-mg dose removed all of 1,613 threadworms from 17 birds. At the rate of 23 mg per bird, the drug removed only 62 percent of 4,097 threadworms from 21 birds. Anthelmintic action was relatively rapid in all instances, as indicated by the elimination of the majority of the worms within 24 hours after treatment. Slight edema at the injection site and a transitory incoordination were observed in some of the treated birds at both dosage levels. However, the ataxia disappeared within 2 or 3 hours, and the birds showed no further ill effects. The 35-mg dose appeared to be optimal. (I) Beltsville, Md.

Treatment for Sheep Scab. Prolate, Malathion, Quinthion, Shell SD 8447, and Co-Ral were tested against the common scab mite of sheep. All, except SD 8447, were successful in eradicating infestations. (I) Albuquerque, N. M.

New Chemotherapy for Fringed Tapeworm. The fringed tapeworm, Thysanosoma actinioides, is responsible for substantial losses from liver condemnations among sheep in the Western States. Until recently, no drug had been shown to have any significant effect against the parasite. In 1962, we reported that bithional removed appreciable numbers of Thysanosoma from sheep and appeared to be reasonably well tolerated. This was the first report of

an effective thysanoxomacide. Subsequent trials with selected chemicals have revealed another compound, Yomesan (2',5-dichloro-4'-nitrosalicylanilide), that shows considerable promise in this regard. The drug substantially reduced infections of the fringed tapeworm when given to sheep at dose rates ranging from approximately 400 to 600 mg/kg of body weight. In trials at the maximum level, only 9 tapeworms were recovered from 1 of 15 principals, whereas 369 tapeworms were recovered from 13 of 14 untreated controls. The number of Thysanosoma was appreciably reduced also at dose rates of about 400 to 500 mg/kg. In these trials, 5 tapeworms were found at necropsy in 1 of 8 treated ewes and 141 in 7 of 9 controls. Yomesan was well tolerated in these dosages. A temporary softening of the feces, in ewes treated at the 600-mg level, was the only indication of toxicity. (I) Beltsville, Md. and Las Cruces, N. M.

General aspects of research partially supported by Hatch and McIntire - Stennis funds. The control of pests of animals with conventional pesticides has been improved. Newer anthelmintic drugs and low volume application of insecticides to control mosquitoes, house flies and face flies showed promise in preliminary tests. A combination of chemical and physical methods proved to be the most satisfactory in providing relief for quarter horses from harassment by face fly feeding. Other ways of improving the effectiveness of conventional insecticides in protecting animals from pests and reducing the hazard of environmental contamination with conventional pesticides were studied. (E) Agr. Exp. Stas. of: Alas., Fla., Kan., Ky., Ind., La., Mont., Okla., Ore., Pa., S. C., Va., W. Va.

Field Crops

Improved fumigation of wheat with recirculation system. Chloropicrin fumigation by the recirculation method of application was highly effective in a test conducted in a large flat storage building containing 100,000 bushels of wheat. The dosage applied was 2 lbs./1,000 cu. ft., recirculated for 2 hours. Average mortality of test insects in 112 locations was 94.8 percent for adult confused flour beetles and 99.2 percent for immature rice weevils. Gas chromatographic analyses of air samples showed that low chloropicrin concentrations were always associated with low insect kill. The system provides more effective fumigation with less fumigant. (I) Manhattan, Kan.

Seed Rot of Rice. Research was conducted on methods to control seed rot in water-seeded rice and damping off in drill-seeded rice. A laboratory method of evaluating chemicals for use in seed treatments was developed. It gave results comparable to those from field tests and may be a practical way of screening new chemicals and a way of reducing the number screened in field tests. (I) Baton Rouge, La.

Aerial sprays - corn. Measurements of aerial spray deposits on corn were made. Spray equipment was attached to a helicopter and flight speeds of 30 and 57 mph. were compared. Deposits of spray on both the top leaf area and under leaf area decreased considerably at the higher helicopter speed. (I) Wooster, Ohio.

Granular insecticides - corn borer larvae. A series of tests were conducted on the use of granular insecticides to control both the first-generation corn borer and the corn rootworm. A total of 9 experiments were conducted at 7 locations. Four compounds were used. All fields were treated twice: the first application when evidence of rootworm feeding was found, and the second application one week later. In one experiment four levels of soil coverage were tried: 1/2 inch, 1-1/2 inches, 2-1/2 inches, and 3-1/2 inches. The differences in control among the different levels of soil coverage were not large enough for significance, indicating a lack of importance for specific amounts of soil coverage level. The results show that rootworms and borers can be controlled with one chemical. (I) Ames, Ia.

Systemic insecticides - corn borer larvae. Studies were continued on the use of systemic insecticides for controlling first-generation corn borer larvae in corn. Four compounds were applied in granular form with the fertilizer at planting time: with the seed, 2 inches to the side of the seed, and 2 inches to the side and 2 inches below the seed. Only one of the compounds gave effective control. The differences in control among the various placements tried were not very large. However, there was some indication that the chemicals applied with the seed caused some phytotoxicity and that placement 2 inches to the side and below the seed gave slightly poorer control. Systemics applied during the first cultivation were not quite as effective as those applied at planting time. (I) Ames, Ia.

Granular insecticides - corn rootworm. Granular insecticides for control of Northern Corn Rootworm were applied to corn plots within two days after the corn was planted. In one plot series where the average larvae population was twelve per plant in untreated corn, five insecticides reduced lodging and produced higher yields (increases from 18 to 34 bu. per acre). (I) Wooster, Ohio.

Soil herbicide application - corn. Field studies were continued to compare the effectiveness of four methods of shallow (above the seed) incorporation of amiben and trifluralin for weed control in soybeans. The rotary hoe, Atkins-Phelps Mix-A-Product, power rotary cultivator, the Gandy Ro-Wheel were used to incorporate the herbicides after the soybeans were planted. There was no particular advantage with these herbicides of incorporating them with the soil. It was again found difficult to maintain an even depth of incorporation in the small soil zone above the seed. (I) Columbia, Mo.

Soil herbicides - corn. Six chemicals were used in order to study soil incorporation of herbicides for weed control in corn. These compounds were applied 5 to 10 days before planting and directly after planting.

Both liquid and granular formulations were used. The pre-plant soil incorporation methods included strip rotary tillage, tandem disking, and no incorporation. The post-plant soil incorporation methods included strip rotary tillage, dragging hoe, and no incorporation. All chemicals resulted in better weed control than the cultivated checks. There were no significant differences in weed control, stands, or yields among the various chemicals used. (I) Ames, Ia.

Weed control in corn. Early spring herbicide applications on corn were evaluated in conjunction with some tillage field plot studies. With the triazine compounds it was possible to obtain satisfactory weed control with only one mechanical cultivation. With the 2,4-D sprays, it was necessary to perform the normal mechanical series in order to control weeds. During recent years, these early spring applications of atrazine and simazine have given more consistent results in terms of weed control than any other type or time of application. (I) Ames, Ia.

Weed control - corn. Field studies were continued to evaluate different methods and equipment for directed applications of dalapon for weed control in corn. Protection varied from no leaf protection to a maximum protection provided by tying the leaves to the corn stalk. A special shield leaf lifter, wire leaf lifter, and directed nozzles were used on the sprayer. It has been determined from 4 years of study that the wire type leaf lifter is satisfactory for application of dalapon in corn. (I) Columbia, Mo.

Grasshopper control with low-volume applications. Low-volume airplane applications of six insecticides gave satisfactory control of grasshoppers under some conditions. Meteorological factors and physical characteristics of the spray were found of greater significance in the low-volume applications than with previously used larger volumes. Very fine atomization of diazinon reduced control whereas fine atomization of Naled appeared desirable. (I) Bozeman, Mont.

Chemical Weed Control in Soybeans. Incorporation of trifluralin and other related herbicides in the soil before planting controlled grassy weeds in soybeans selectively and effectively. Non-directed post-emergence sprays of chloroxuron controlled many broadleaf weeds in soybeans with little injury to the crop. These findings represent significant progress in developing single components for multiple component systems of weed control in soybeans. (I) Stoneville, Miss; Urbana, Ill.

Weed control - soybeans. Field studies were continued to determine the effectiveness of 8-, 10-, 12-, 14-, and 16-inch band applications of amiben and Na-PCP for weed control in soybeans. The narrow band widths had a greater number of weeds though not enough to reduce soybean yields. Very little lateral movement of the herbicide was observed for any of the band widths. (I) Columbia, Mo.

Soil herbicides - soybeans. Two chemicals in liquid form and three in granular form were applied to study soil incorporation of preemergence

herbicides for weed control in soybeans. Soil incorporation treatments included power rotary strip tillage before planting, disking and harrowing before planting, harrowing after planting, and no incorporation. All chemically treated plots received one mechanical cultivation. The untreated check plots were rotary hoed and cultivated once. Surviving weeds as indicated by weed weights obtained in August, and yield data showed that the weed control and yields were not materially improved where chemicals were used. (I) Ames, Ia.

Soil-herbicide application - soybeans. Field studies were initiated to further study methods and equipment for incorporation of herbicides prior to planting soybeans. The power rotary cultivator, Atkins-Phelps Mix-A-Product, and the disk harrow were used to incorporate trifluralin and amiben in field plots. All incorporation was done at an operating depth of 4 inches. The herbicides were applied just ahead of the incorporation equipment. The soybeans yields were the same for all incorporation treatments and for those plots that did not receive the incorporation treatments. (I) Columbia, Mo.

Improved pesticides for insects in stored peanuts. Diazinon and fenthion at application rates up to 20 p.p.m. were not as effective as the standard malathion treatment and were not at all effective after 6 months, in small-bin intermediate scale tests with farmers' stock peanuts. After 9 months of storage the peanuts originally treated with 20 p.p.m. of diazinon contained less than 1 p.p.m. of deposit. (I) Tifton, Ga.

Boll weevil diapause control. Two dosages of azinphosmethyl applied by airplane as an ultra low-volume spray in the fall of 1965 were as effective against boll weevils as the methyl parathion standard applied conventionally in a boll weevil reproductive-diapause control experiment. Results of extensive woods trash examinations in the fall indicated that the treatments gave 94% population reduction when compared with the untreated check. Examination of woods trash in the spring of 1966 showed a 98% reduction in boll weevil numbers near treated fields compared with untreated fields. (I) State College, Miss.

Boll weevil control with low-volumes. Two ground sprayers were developed for applying low-volume pesticide concentrates. One utilized a 3-outlet mist blower equipped with "minispin" nozzles and a pressure unit. The other utilized a rotary disc device employing centrifugal force to produce the spray. Both machines applying malathion or azinphosmethyl gave boll weevil control comparable to that obtained with conventional applications of methyl parathion. (I) Florence, S. C., and State College, Miss.

Application of systemic insecticides to cotton stems. A systemic insecticide applied to the stem of cotton plants controlled cotton fleahoppers and lygus bugs in field tests. Azodrin applied with a tractor-mounted brush stem-treatment applicator controlled cotton fleahoppers for 2 to 3 weeks in Central Texas. In a test in Arizona, Lygus hesperus, were controlled for 2 to 3 weeks on cotton 3 to 4 feet tall with Azodrin applied to the stems. (I) Waco, Tex., and Tucson, Ariz.

Control of Boll weevil by slow-release insecticide. In preliminary greenhouse soil treatment tests, a simulated slow release formulation of Temik was more effective against boll weevils than the granular formulation currently available. In most experiments the same amount of Temik distributed in four weekly applications to potted cotton plants was more effective than when applied in a single treatment. (I) College Sta., Tex.

Effect of application methods on residue persistence. A field study was conducted at Emporia, Virginia, to measure the magnitude and persistence of residues of low-volume and conventional emulsion sprays of malathion and methyl parathion on cotton foliage for insect control. It was shown that there was little difference in the magnitude or persistence of malathion residues deposited by low-volume and emulsion sprays when applied by airplane. Ground application of emulsion sprays gave smaller residues than aerial application. There was no difference in the magnitude or persistence of methyl parathion residues deposited by low-volume or by emulsion sprays. (I) Beltsville, Md.

Experiments to reduce fumigation of stored tobacco. Several hundred hogsheads of tobacco were sold after storage 4 to 5 years in warehouses fumigated heavily with HCN each spring, then treated twice weekly with dichlorvos during the insect season. Insect damage did not exceed trace amounts. To determine whether the number of fumigations can be reduced, other warehouses were given one HCN fumigation and treated with dichlorvos 5 days a week during the insect season. After 2 years, only a few insects were present and no damage to tobacco was detected. To determine whether fumigation could be eliminated, new crop tobacco was placed in 6 new warehouses and dichlorvos applied 5 days a week during the insect season. After 1 1/2 years of storage, the insect population appeared to be increasing and some damaged tobacco was found. (I) Richmond, Va.

Wireworm control in Tobacco. A method for applying insecticide granules as a row treatment on tobacco was developed in cooperation with industry. The equipment permits application at 2 different levels in the soil. Cooperative tests are being conducted with Crops Research Division in an effort to combine treatments for wireworm and nematode control. (I) Florence, S. C.

Chemical Control of Weeds in Sugarcane. Johnsongrass and Raoul grass are two serious pests in sugarcane. Recent research shows that MSMA, applied post-emergence, will control both weeds. Arsenic residues in the cane were negligible if treated before June. Residues were found, however, from later applications. Winter weeds severely retarded growth of sugarcane in the spring. Preemergence control of these winter weeds with simazine resulted in more stalks of cane at harvest. (I) Houma, La.

Sugarbeet Weed Control by Herbicides. Combinations of herbicides at reduced amounts of total chemical applied postemergence controlled many species of broadleaf weeds in sugarbeets at 8 locations in the North Central States. (I) St. Paul, Minn.; Fort Collins, Colo.

General aspects of research partially supported by Hatch and McIntyre - Stennis funds. The use and application of conventional insecticides, fungicides, herbicides and other pesticides has been improved. Better weed control was obtained when trifluralin was incorporated in the soil at one to five inches in depth. There was no apparent benefit of incorporating the material to depths greater than one inch. Super-imposing foliar sprays of Bordeaux mixture upon soil applications of Difolatan applied before the last cultivation drastically reduced the germination of potato late blight sporangia. A tractor-mounted rotary-brush applicator was developed and proved highly effective in applying systemic insecticides to control infestations of fleahoppers and lygus bugs in cotton. Other approaches to improving the control of pests with conventional pesticides and reducing detrimental effects of these pesticides in the environment were made. (E) Agr. Exp. Stas. of: Ala., Ariz., Ark., Del., Fla., Ga., Kan., Ky., La., Me., Md., Mich., Minn., Miss., Mo., Mont., Nebr., Nev., N. Mex., N. Y., Ithaca, N. C., N. Dak., Okla., Ohio, Pa., P.R., R. I., Tenn., Tex., Va., Wash., W. Va., Wis., Wyo.

Horticultural Crops

Effect of Repeated Long-term Use of Herbicides in Perennial Fruit Crop Plantings. Though several herbicides have been used for a number of years on apple, peach, blueberry, and cranberry plantings, little is known about the effect of such treatments on the yield, quality, and longevity of these treated crops. In research that has been in progress for more than 5 years, repeated annual applications of effective herbicides have not caused undesirable effects on a number of these crops. The studies are being intensified to include additional basic plant and soil research.

(I) New Brunswick, N. J.

Vegetable insect control. Cabbage, turnips, potatoes, peppers, and eggplant were treated with ultra low volume malathion at application rates of 8, 16, and 24 oz. per acre using a sprayer fitted with compressed air atomizing nozzles. Potato leaf hopper and potato flea beetle were controlled equally well with the ULV malathion compared to emulsifiable malathion applied with conventional hydraulic spray equipment. Control of pests (imported cabbage worm, turnip aphid, two-spotted mite, green peach aphid), on the other vegetables was either poor for applications by both types of equipment, or the ULV malathion applications did not achieve control equal to the ordinary hydraulic spray applications. (I) Wooster, Ohio.

Effects of Herbicides on Composition of Vegetable Crops. Tomato and potato plantings treated with approved herbicides were examined for quality factors and vitamin and mineral content. Initial data have not shown a significant shift in the measured factors. The project is being continued in order to obtain additional information on these important staple foods. (E) Ohio State Univ.

Residue deposits from low-volume applications. Analyses of malathion residues on potato foliage showed that initial deposits from low volume applications were about twice that from emulsifiable concentrates. After 14 days the low volume residues persisting on the foliage were 9 times that of the latter.
(I) Yakima, Wash.

Chemical Control of Peach Diseases. Soil injections with 1,2-dibromo-3-chloropropane decreased the loss of trees infected with bacterial canker (*Pseudomonas syringae*). Applications of the antibiotic oxytetracycline (*Terramycin*) during the growing season showed excellent promise in the control of the peach bacterial spot disease. Dodine-captan combination and difolitan resulted in satisfactory control of peach brown rot and scab but not of bacterial spot. The dodine-captan combination was too phytotoxic to peach foliage for further consideration. The form and size of the cuticle projection over peach leaf stomates does not appear to be the basis of resistance to the bacterial spot disease in certain peach cultivars.
(I) Clemson, S. C.

Chemical Control of Apple Mildew. Karathane gave excellent control of a powdery mildew epidemic in apples. When dimethyl sulfoxide (DSMO) was added to the spray, the karathane content could be effectively reduced by 50 percent. Morestan miticide gave excellent control of powdery mildew when the miticide was applied at the rate of 1/4 to 1/2 lb/100 gallons.
(I) Beltsville, Md., Hood River, Ore.

Airplane Applications for Mite Control. Airplane applications of low volume technical malathion sprays reduced McDaniel mite populations on apples to one-third that of plots where conventional dilute malathion was applied. Within 10 days, however, populations in both plots had doubled, while there was a slight decrease in population in a plot treated with dicofol. Airplane applications of low-volume malathion sprays to deciduous fruit trees resulted in higher residues than the conventional malathion sprays. Residues were more persistent with the low-volume sprays.
(I) Yakima, Wash.

Bactericide Tests to Control Pear Bacterial Blight. *Pseudomonas* blight was particularly severe at Hood River, Oregon, in the spring of 1965; up to 50 percent of the blossoms in some orchards were blighted and killed. Blighted buds not killed produced pitted and misshaped fruit. Pathogenic cultures were used to standardize a screening technique used to test the effectiveness of bactericides during bloom. (I) Hood River, Ore.

Citrus insect control with a systemic insecticide. Applications of a granular formulation of Temik at the base of two-year-old orange trees gave control of citrus red mite, citrus thrips, and spirea aphids for 44, 10 and 29 weeks, respectively. Similar treatments gave control of brown soft scale for up to 15 weeks. (I) Riverside, Calif., and Weslaco, Tex.

General aspects of research partially supported by Hatch and McIntyre - Stennis funds. The use of conventional pesticides in protecting horticultural

crops and minimizing the possibility of contamination of the environment with pesticide residues has been improved. Weed control in sweetpotatoes and other crops was obtained without depressing yield when several herbicides were used and applied in different manners. Candidate miticides of low mammalian toxicity and various classes of chemical structure showed promise against mites infesting apple trees. Studies were made on the fungi toxicity of compounds. Progress was made along other lines of improving the effectiveness of conventional pesticides used on horticultural crops and reducing the hazards of environmental contamination. (E) Agr. Exp. Stas. in: Ala., Alas., Ariz., Ark., Calif., Davis, Riverside, Conn., Del., Ga., Haw., Ill., Kan., Ky., La., Me., Md., Mass., Mich., Minn., Miss., Mo., Nebr., N. J., N. Y., Geneva, Ithaca, N. C., Ohio, Ore. Pa., P. R., R. I., S. C., W. Va., Wis.

Forests

Determination of Spray Distribution. One way to decrease the hazard from aerial spray applications of chemical insecticides is to increase the efficiency of the spray distribution. In order to learn more about where spray applications were going, insoluble fluorescent particles of microscopic size were suspended in test spray solutions. It was found that the number of particles that are carried by a given spray droplet is proportional to the size of the droplet. As these particles do not penetrate tissue and do not fade on exposure to the elements, it is possible to determine the number and size of droplets that hit target or non-target insects, plants or other elements of the environment. This development greatly facilitates studies now underway on the nature of spray distribution. (I) Berkeley, Calif.

Low volume application to forests. Atomization studies of 95% malathion applied at low volume from an airplane were made comparing the "Mini-Spin" spray device with conventional nozzles. The degree of atomization influences the distribution of the spray across the swath, as well as its loss caused by evaporation, drift, and convection. The "Mini-Spin" produced a lower percentage of both fine drops and the coarse drops than did the conventional nozzles. (I) Beltsville, Md.

Increased germination by seed treatment. Hydrogen peroxide treatment of seeds of six woody plant species markedly reduced seed-borne microorganisms and increased germination. The tests indicated that the greatest benefit might be derived from the near complete elimination of contaminating microflora and the subsequent prevention of pre-emergence and post-emergence damping off. For ponderosa pine a 50 percent increase in seed germination was obtained. (I) Albuquerque, N. M.

Reduction of bark beetles by herbicides. A fast-acting herbicide significantly reduced broods of four bark beetle species in naturally infested trees in the Southwest. The herbicide was injected directly into the sap

stream of the trees near ground level. Application was made soon after the attack, before the majority of the eggs had hatched. Some added values of using the fast-acting herbicide to control bark beetles were (1) ease of application, (2) low cost of treatment, (3) safety for the applicator and the environment, and (4) reduced hazard to non-target insects. (I) Albuquerque, N. M.

Fungicidal Screening for Blister Rust. Nearly fifty chemical fungicides have been studied in an attempt to find a safer, more effective control of blister rust on sugar pine. Both antifungal antibiotics and conventional chemical fungicides have been applied through direct and systemic treatments but with no success to date. (I) Berkeley, Calif.

Wood change under storage. With water spray storage the normal fungus flora which is excluded by the near oxygen-free conditions is largely replaced by bacteria and actinomycetes. These organisms are apparently responsible for degradation of the wood parenchyma with a consequent great increase in the permeability of the wood. This effect could be of considerable importance in the uptake and retention of preservatives. (I) Madison, Wisc.

Limb rust control. Chemical therapeutants, although economically promising, have proved biologically ineffective, for the control of limb rust of ponderosa and Jeffrey pines. In larger stems fungal tissues were found to grow within the inner sapwood rather than in the bark. It seems probable that the present methods of injecting chemicals fail to reach deep-seated portions of the rust fungus and new control techniques are necessary. (I) Logan, Utah.

Spores for resistance tests in longleaf pine. Large numbers of spores of the brown spot fungus, Scirrhia acicola are necessary in order to inoculate longleaf pine seedlings to test for genetic resistance or the effects of fungicides. Various liquid media were used to grow the fungus in an attempt to produce the maximum numbers of spores. Nutrients favoring mycelial growth induced little spore production. (I) Gulfport, Miss.

Comandra rust of lodgepole pine. Several derivatives and formulations of the antibiotic cycloheximide were tested for their effectiveness as a control for comandra rust of lodgepole pine. After four years none of the antibiotic materials, at the concentrations and rates used, killed the fungus Cronartium comandrae nor controlled the disease. (I) Moscow, Idaho.

Ultra-low volume insecticidal spraying. Malathion concentrate, a non-persistent insecticide, sprayed at the rate of 8 and 13 fluid ounces per acre was tested for control of spruce budworm on the Lewis and Clark National Forest, Montana. The 13-ounce application yielded satisfactory results and provides an interim means of controlling spruce budworm under conditions in the test area. (I) Missoula, Mont.

Pilot test of Zectran. Field testing of promising new non-persistent insecticides to replace and thereby minimize the adverse effects of DDT and other chlorinated hydrocarbons was continued on the Bitterroot National Forest, Montana. The carbamate insecticide, Zectran, used at the rate of 0.15 pounds per gallon of kerosene per acre yielded approximately 87 percent kill of the spruce budworm without measurable adverse effects to fish, fish food organisms, game and song birds and small mammals. (I) Missoula, Mont.

Spraying to control cone and seed insects. High volume insecticide applications by hydraulic spraying are generally an effective method for controlling cone and seed insects in southern pine seed orchards. They are expensive, however, and as the trees grow taller, total coverage becomes increasingly difficult. Results of a recent study indicate that mist blower applications may be superior. Seed yield was nearly as good using the mist blower treatment, and also the cost was cut in half and taller trees could be adequately covered by the mist blower. (I) Olustee, Fla.

Control of insects affecting young trees. Survival of planted trees on cutover pine land in the Southeast is often seriously reduced by weevils. Studies of methods for protecting seedlings from the pales weevil, one of the most important of these pests, have shown that dipping the seedlings in 5% DDT emulsion prior to planting provides protection equal to that of the previously recommended 2% aldrin. DDT can therefore be substituted where danger of aldrin toxicity to mammals or birds is a limiting factor. (I) Asheville, North Carolina.

Reduction of malformation of young trees. Young hardwood trees may be seriously damaged by insects that cause trunk forking and malformation, and reduce height growth. The systemic insecticide Phorate, applied to cuttings at the time of planting, protects the cuttings from several different kinds of insects throughout the first growing season. Phorate applied to the soil has provided protection during the second and third seasons. At 7 years of age, stands treated during the first three years contained about 5 cords of pulpwood per acre more than untreated stands under the same site conditions. This is mostly due to the superior form and lack of forking and crook in the protected trees. (I) Stoneville, Miss.

Brush Control by Aerial Application. Field tests were made to measure the penetration of aerially applied spray through foliage canopies. Spray distribution measurements indicated that conventional water sprays and oil-water emulsion sprays were more uniformly distributed within the swath than were invert emulsion sprays or particulated sprays. (I) College Station, Tex.

General aspects of research partially supported by Hatch and McIntyre - Stennis funds. Effective herbicides were found for use in forest nurseries. In other herbicide tests in soil the rates used caused no significant reduction in fungi or actinomycetes and reduced bacteria in the first assay

only after application. Progress was made in the search for new chemotherapeutants for wilt disease of trees. Other lines of research were pursued to improve the use of conventional pesticides and minimize the environmental hazard in pest control in forests and forest trees. (E) Agr. Exp. Stas. in: Conn., Me., Mass., Mich., N. Y., Ithaca, Pa., Wis.

TARGET IV

TO STUDY THE TOXICITY, PATHOLOGY AND METABOLISM OF PESTICIDES
AND INVESTIGATE LEVELS, EFFECT, AND FATE OF THEIR RESIDUES
IN PLANTS, ANIMALS AND THEIR PRODUCTS, AND IN THE
ENVIRONMENT

General

Insecticide - predator relationship. Studies were conducted at Rolling Fork, Mississippi, on the effect on insect predator populations of insecticides applied as needed in early-season and late-season cotton insect control programs. Nabids, big eyed bugs, and lady beetles were most abundant in early season. Orius was the dominant species in mid-season and populations reached a peak in mid-June. Spider populations increased by mid-season and were dominant from mid--through late-season. All predators were reduced drastically by the late-season insecticide applications.
(E) Miss., State Univ.

Toxicity of new compounds to honey bees. Research now underway includes investigation of the toxicological effect of new experimental insecticides on the honey bee. This information is needed before rather than after these insecticides are placed on the market to obtain protection of the honey bee. Exposures of honey bee colonies to Bacillus thuringiensis and other biological insecticides has established the safety of these materials in relation to the honey bee. (I) Beltsville, Md.

Toxicity of Mosquito Larvicide. The chronic effects of a chemical compound intended for use as a mosquito larvicide were found to be partial anorexia and lameness in cattle following daily oral dosages ranging from 1.1 to 1.4 mg/kg. beginning in the fourth month of exposure. No ill effects were observed in sheep similarly treated or cattle and sheep exposed by an emulsion in the drinking water at a concentration 10 to 20-fold greater than that recommended. (I) Kerrville, Tex.

Phytotoxic Interactions From Pesticide Combinations. Phytotoxic interactions resulted from combinations of pesticides in soils. Synergistic phytotoxicity resulted from combinations of Di-Syston, phorate, or carbaryl with diuron. Additive phytotoxicity resulted from combinations of Di-Syston, phorate, carbaryl, or DDT with dalapon. Phytotoxic interactions were not demonstrated in several other pesticide combinations. A comprehensive screening for other phytotoxic interactions is being conducted. (I) Beltsville, Md.

Hazard of Multiple Pesticides Interaction. Research results have shown that care must be exercised in applying the technique of one-shot multiple applications of pesticides to crop plants. Experiments with cotton demonstrated that mixtures of the herbicides monuron or diuron with the insecticides phorate or Di-syston resulted in greater injury to the crop plant than application of any of the pesticides applied alone. These results point up the need for careful evaluations where the use of pesticide mixtures are contemplated. (I) College Station, Tex.

Synergizing Effects of Phenothiazine. The potentiation of synergizing effects of phenothiazine-lead arsenate anthelmintic in sheep subsequent to organophosphorus insecticide exposure was investigated. Only a greater reduction in whole blood cholinesterase activity in the group drenched with the anthelmintic preparation was seen. The potentiation of phenothiazine, with and without the administration of Vitamin A, to cattle following exposure to a commercial formulation combining 2 different organophosphorus insecticides is also receiving attention. (I) Kerrville, Tex.

Concentration of pesticides by wireworms. Wireworm larvae exposed to soil containing 2.5 p.p.m. of aldrin for 9 days contained 21 p.p.m. of aldrin plus dieldrin. This decreased to 18 p.p.m. after 7 days in insecticide-free soil and to 8.2 p.p.m. after 28 days. The insecticide-free soil then contained as much as 0.009 p.p.m. of aldrin plus dieldrin, apparently excreted by the larvae. (I) Yakima, Wash.

Effect of Synthetic Growth Inhibitors and Stimulants on Dormancy and Drought and Low-temperature tolerance of Weeds. An effective means of regulating dormancy and drought and low-temperature tolerance of weeds would be a major advance in the use of climatic conditions to assist in control of weeds with a minimum of chemicals. Research has been initiated on the influence of herbicides on sensitivity of weeds to low temperatures. Other studies on the effect of plant age and physiological condition on frost sensitivity of weeds are in progress. Factors involved in the uptake of synthetic inhibitors and stimulants by germinating weed seed are being measured by the use of radioactively tagged elements. The development of effective experimental methods is a crucial problem in this research and progress is being made in this area which should facilitate the achievement of the ultimate goals of the program. (E) Univ. of Wisc.

Microbial activity - pesticide reaction. The microbial activity in various soils was evaluated in a study with various chlorinated hydrocarbons. Results showed that some pesticides severely inhibited activity at low concentrations while high concentrations of other compounds were required before any inhibition was evident. (I) Fort Collins, Colo.

Microbial Decomposition of Pesticide Combinations. Microbial decomposition of certain pesticides may be enhanced, inhibited or unaffected by the presence of residues of other pesticides. Biological and chemical assay of greenhouse soils indicated that dalapon persisted longer in soils when applied in combination with amitrole. Dalapon had no effect on the persistence of amitrole. Decomposition of dicamba occurs more rapidly in soils treated simultaneously with 2,4-D. Bioassays of treated soils indicated that the herbicide CIPC persists longer in soils containing residues of the insecticide Carbaryl. The mechanism of this effect of Carbaryl on CIPC is being studied at the molecular level with an isolated enzyme system. Additional deleterious and beneficial pesticide combinations are being investigated. (I) Beltsville, Md.

Structural Effects on Microbial Degradation of Pesticides. Number, type, and position of chemical substituents on the basic molecule affects the resistance of pesticides to microbial decomposition. The rate of microbial decomposition of certain aliphatic acid pesticides decreases as the number and position of halogens on the molecule changes. Halogen substituents also limit microbial decomposition of pesticides having basic ring structures. The size and type of substituent or side chain and type of linkage to the ring affects decomposition rates of the basic ring structure, and may also affect the pattern of substituent positions resistant or susceptible to microbial decomposition. Such information may lead to the formation of pesticides which provide adequate control of the pest, but leave little or no residues. (I) Beltsville, Md.

Biochemical Pathways of Pesticide Degradation. Current studies show that the rate of metabolism of the triazine, phenylurea, and carbamate herbicides by enzyme preparations from plants is very slow. In a few instances, however, isolated plant enzyme systems are able to modify the herbicide rapidly by formation of glucose complexes with the nitrogen atom of an amino group. The details of the glycolysation reaction as a mechanism for detoxifying amiben are being elucidated. (I) Fargo, N. D.

Mode of Insecticide Action and Development of Resistance; Stored-product Insects. Six strains of Cadra cautella, two strains of Plodia interpunctella, and two strains of Tribolium castaneum collected from storage or processing facilities were investigated for resistance to malathion. The most resistant strains of these species were 5.8, 16.4, and 2.1 times as resistant, respectively, as the normal laboratory strains. Diazinon and BAY 77488 were investigated for toxicity to malathion-resistant strains of T. castaneum. Although the malathion-resistant strains were also more tolerant of these chemicals than were the standard laboratory insects, they exhibited lower tolerance to BAY 77488 than to malathion, indicating promise for this compound in controlling malathion-resistant insects. (I) Savannah, Ga.

Detoxication enzymes - stored product insects. A study was initiated to determine the changes that occur in the activities of oxidative detoxication enzymes as related to age and growth stage of stored-product insects. (E) Iowa State U.

Mode of Action of Herbicides. Herbicides are bound or otherwise associated with various constituents of cellular materials. Diuron, several N-phenyl carbamates, 2,4-D, 2,3,6-TBA and several dinitrophenols bind to inert protein. Binding appears to be on the amino groups of the protein and to involve more than simple hydrogen bonding. The triazine herbicide, prometryne, is trapped in the cell wall of cotton plants and appears to be associated with pectic materials and hemicellulose. In isolated spinach chloroplasts, prometryne, simazine, and propanil distribute between active sites (where the compounds inhibit photosynthesis) and inactive sites. Increasing acidity increases the amount of simazine associated with active sites. (I) Raleigh, N. C.

Physiological Effects of Monuron and Atrazine reduced by Minerals. Feeding cattle mineral elements known to stimulate rumen flora (phosphorus, sodium, potassium, cobalt and sulphur) reduced physiological effects from ingesting plants treated with monuron and atrazine. (I) Logan, Utah.

Fate of Amiben Herbicide. It has been clearly demonstrated that amiben is rapidly absorbed by roots of soybean, sugarbeet, squash, cucumber, and other species, and rapidly converted to the amiben N-glucoside. This metabolite is highly stable in root tissue where it is formed and is not readily translocated. These studies showed that the glucoside of amiben persisted undiminished in soybean roots for at least 50 days after treatment. (I) Fargo, N. D.

Atrazine Metabolism. Studies of the fate of atrazine in peas, sorghum, and wheat show that loss of one or the other of the alkyl side-chains on the basic ring structure is an important mechanism for the degradation of this herbicide. In addition to providing important new data on residues of previously unsuspected metabolites of atrazine, the studies help to explain differential susceptibility to the chemical. (I) Fargo, N. D.

Plant Absorption of Pesticides. Quantitative absorption of pesticides by plants is being studied. One of the objectives of this project is to determine how much pesticide enters the food chain from plants grown on soils containing residues of insecticides and herbicides. Another objective is to determine the soil properties that effect pesticide uptake. Diuron-C¹⁴ absorption from soil by oats increased with increased soil pH, temperature, and moisture content. Diuron-C¹⁴ absorption decreased with increased soil organic matter, clay, and cation exchange capacity. Research on plant absorption of the chlorinated hydrocarbon insecticides is being conducted in soils with known histories and in the greenhouse using both labeled and nonlabeled insecticides. DDT was phytotoxic to soybeans 17 years after application of 400 lb/A or more in longtime persistence studies. (I) Beltsville, Md.

Leaching of pesticides. In a study to determine the effect of continuous leaching on the movement of pesticides in soils, the downward movement of the chlorinated hydrocarbons was very small irrespective of soil texture or the amount of water used. In most cases, more than 99 percent of the applied pesticide remained in the top 6 cm. of soil at the end of the experiment. (I) Fort Collins, Colo.

Pesticide adsorption by soil. In a study to evaluate the forces responsible for pesticide adsorption by organic colloids, results showed that the recovery of DDT from humic acid colloids was decreased by increasing the temperature. These data suggest that physical forces exist between the pesticide and organic colloids and that these physical forces retard volatilization of the pesticide. The contribution of soil organic matter to pesticide adsorption in soil was studied in an experiment by removing organic materials by organic solvent extraction in one set of samples. Results showed that the organic fraction in the soil plays an important role in pesticide adsorption. (I) Fort Collins, Colo.

Pesticide desorption by soil. Soil moisture content plays an important role in adsorption and desorption of pesticides. Experiments to date show that extent and reversibility of the effect vary with the pesticide and that certain pesticides, notably heptachlor and endrin, degrade in soil under dry conditions. (I) Beltsville, Md.

Fate of Organic Arsenicals in Soil. The fate of DSMA (disodium methyl-ane arsonate) has been studied in soils using the C^{14} labeled molecule. Although microbial degradation does occur in soil, mineralization of the DSMA moiety and subsequent release of $C^{14}O_2$ occurs but slowly, approximately 6.5 percent of the C^{14} material applied being evolved as $C^{14}O_2$ in 60 days. Incorporation of C^{14} -methyl group into cellular constituents, however, may preclude its evolution as $C^{14}O_2$. Preliminary data collected from some soil microorganism culture work suggests that an unidentified soil fungus is capable of metabolizing DSMA and evolving the labeled carbon as $C^{14}O_2$. Work is presently underway to identify the products resulting from metabolism. The products may have a higher mammalian toxicity than the parent compound. (I) Beltsville, Md.

Herbicide adsorption by soil. Studies on the role of soil factors responsible for the adsorption of herbicides have shown the importance of soil acidity on herbicide adsorption. Distribution coefficients were decreased by increasing the pH. In an evaluation of the influence of clay minerals on the adsorption of several herbicides, results showed the following order of decreasing adsorption: prometryne > simazine > propazine > atrazine. (I) Beltsville, Md.

Decomposition of DDT in soil. In a study conducted to determine if the decomposition of DDT in soils could be enhanced by increasing the microbial activity with various amounts of alfalfa meal, results showed that DDT was completely decomposed after 2 weeks incubation under anaerobic conditions. Further experimentation under controlled conditions will be required to clarify these findings. (I) Fort Collins, Colo.

Movement of pesticides used for termite control. Persistent chlorinated hydrocarbon insecticides are used for termite prevention throughout the world. Much of the research on which these treatments are based has been done on an experimental area in southern Mississippi. Tests have recently been started in this heavily treated research area to find out if these insecticides, introduced into the soil, have moved through the soil to contaminate nearby water supplies. Preliminary results indicate that they have not, and that the insecticides have remained as placed. It is believed that when these materials are used under buildings, where they are not subjected to forces of weather, the chances of their remaining as placed are even greater. (I) Gulfport, Miss.

Fate of Herbicide in Irrigation Water, Crops, and Soil. A system for furrow and overhead irrigation of small field plots was developed by CR personnel for use in a 3-year extramural research program on the fate of 4 to 6 herbicides applied at 3 concentrations to corn, soybeans, and sugarbeets. An irrigation canal was treated with copper sulfate and samples for chemical analyses taken of water, aquatic plants, and bottom soil at appropriate distances and time intervals after the application. (I) Prosser, Wash., (E) Battelle Memorial Institute.

Persistence of Herbicides in Water. Only 26 percent of an application of diquat at 1.0 ppmw in a reservoir for weed control remained in the water 0.5 hour later and only 0.009 ppmw was present 12 days later. Paraquat persisted longer with 27 percent still present in the water 24 hours after application and 0.018 remaining after 13 days. Diquat also disappeared rapidly from water in experimental growth pools 4'x4' containing a small amount of soil in the bottom. More than 50 percent of the copper sulfate and endothall applied in the growth pools remained in the water 12 days after the applications. (I) Davis, Calif.

Runoff of herbicides. Field studies showed that the loss of 2,4-D in washoff (runoff plus soil loss) was reduced by increasing the time between the chemical application and the rainfall by lowering temperature of rainwater and by using the amino form rather than the ester form. Losses of the amino form were lower because it was more soluble than the ester form and thus was carried several inches deeper into the soil by infiltrating rainwater. (I) Watkinsville, Ga.

Contamination of farm water supplies. Studies are under way to determine if present agricultural pesticide application practices constitute a possible threat of contamination to the various farmstead water supply sources. As these studies progress, plans are being formulated to develop, if necessary, application methods and equipment which will aid in preventing pesticide pollution of the farm water supply. Plans are also under way to investigate the design criteria of methods and equipment suitable for purifying the farmstead water supply if it is polluted with pesticides. (I) Watkinsville, Ga., and Beltsville, Md.

Pesticide extraction methods. Studies designed to evaluate the extraction methods which will accurately evaluate pesticides in water samples suggest that a hexone extraction will recover the greatest amount. In soils, present results indicate that a 12-hour soxhlet extraction of soil with the ozeotropic hexane:acetone (41:59) mixture will give complete extraction of DDT and lindane. (E) Univ. of Wisc.

Removal of Residues from Tomatoes During Commercial and Home Preparation. More than half of carbaryl residues and two-thirds of DDT residues were removed from field treated tomatoes by cold water washing. Nearly complete removal of the remaining residue was realized by peeling and canning operations. There was no loss of carbaryl or DDT during storage of the raw unwashed fruit at 55° F. for about approximately one week. (E) National Cannery Association, Wash., D. C.

Pesticide residue detection on stored agricultural commodities. During 1966, 3,394 analyses of pesticide residues were made to support the entomological research on stored-product insects. An additional 927 analyses were conducted to determine fumigant residues in wheat, flour, and bread in a cooperative study with the Human Nutrition Research Division being conducted to study the effects of fumigants on nutritional factors in food. (I) Savannah, Ga.

General aspects of research partially supported by Hatch and McIntyre - Stennis funds. The residues of pesticides have been determined in many agricultural crops and products, soils and waters. Different pesticides move through the soil and are decomposed in the soil at different rates. Some soil microorganisms decompose pesticides. Some pesticides have a marked effect on soil microorganisms and some have little effect. Research has also shown that water is an important factor in the movement of some pesticides. The solubility of pesticides in various waters is being studied. Biologically and physically produced degradation products of pesticides are being determined. Water and air pollution and the physiological action of pesticides and their degradation products in plants are under study. Studies are underway in the removal of pesticide residues from fresh produce. Research is in progress in other areas of toxicology, the fate of pesticide residues and their occurrence in crops, soil, water, air, and other components in the environment. (E) Agr. Exp. Stas. of: Ala., Ariz., Ark., Calif., Davis, Riverside, Colo., Conn., Fla., Ga., Haw., Ida., Ill., Ind., Iowa., Kan., Ky., La., Me., Md., Mass., Mich., Minn., Miss., Mo., Mont., Nev., N. J., N. Mex., N. Y., Geneva, N. Y., Ithaca, N. C., N. Dak., Ohio, Okla., Ore., Pa., R. I., P. R., S. C., Tenn., Tex., Utah, Vt., Va., Wash., Wis., Wyo.

Animals

Chemosterilant toxicity. Toxicological studies are being made on small animals with a number of chemosterilants to determine what safeguards are

necessary for their use. Tepa and hempa, among the most promising of the materials, are being studied in depth. (E) Hazelton Labs., Inc.

Effect of Organic Phosphate Insecticides on Cattle. Research programs are being conducted on the effect of organic phosphate systemic insecticides on embryonic survival and development in cattle. (E) Mont. State Univ., and Univ. of Nebr.

Metabolism of Diuron. A study has been undertaken on the fate and metabolism of Diuron in ruminants. (E) Tuskegee Institute.

Removal of DDT from Chickens. Investigations have been initiated on feeding practices to remove DDT from body tissues and eggs of chickens. (E) Univ. of Ga.

New Studies on Residues. A study was initiated at Ithaca, New York, on the reproduction of mink when fed Great Lakes fish containing pesticide residues. Work was initiated at Beltsville, Maryland, on the possible occurrence of residues in dairy cattle and milk when chemicals are fed to kill insect larva deposited in freshly excreted feces. Investigations were stepped up at Beltsville to determine the existence of residues in pork when market hogs get pesticide contaminated feeds. (I) Beltsville, Md., and Ithaca, N. Y.

Dimethoate, DDT, DDE and Heptachlor residues in cattle. At relatively high levels of feeding Dimethoate to dairy cows, an oxygen analog of this compound is excreted in the milk even though no Dimethoate is detectable. Also, studies with DDT and DDE showed their absorption, retention and excretion by cattle were the same whether they were fed singly or in combination. Residues of DDT in lactating cows' tissues were lower than in steers, presumably because of the residues excreted in the milk. Heptachlor residues in steers continued to increase even after they were placed on uncontaminated feeds. The increases were least for steers fed all they could eat, greatest for steers on a limited feed, and intermediate for steers fed all they could eat of the same rations as that fed the other two groups except that protomone was added. The increase in residues was inversely proportional to the weight gain of the groups. (I) Beltsville, Md.

Residues and effects of Imidan in cattle. Imidan residues disappeared from corn plants rapidly before ensiling. The disappearance was slow in the silo. No residues were found in milk when corn treated with 32 oz. of Imidan per acre was fed as silage to cows. Cholinesterase inhibition in the animals fed this silage was decreased by 20%. However, when corn treated with 8 and 16 oz. of Imidan per acre was fed as silage to lactating cows, no decrease in cholinesterase was observed. The possibility of a relationship between feeding corn silage containing Imidan and the occurrence of abortions was evaluated. No evidence of such a relationship was found. (I) Tifton, Ga.

Residues of 2,4D in Lambs. Feeder lambs were fed 2,4D daily for 60 and 90 day periods without causing physiopathological effects and tissue residues did not exceed those in the control animals. (I) Logan, Utah.

General aspects of research partially supported by Hatch and McIntire - Stennis funds. Pesticide residues in animals and animal products have been investigated. Work is in progress on the effect of chemical compounds on the storage of chlorinated hydrocarbons in dairy cattle. Results have been obtained on the electrical responses of various areas of the brain of rats given DDT. Feeding hay treated with chlorinated hydrocarbon insecticides showed the time required for the insecticide to appear in the milk and the amount after different periods of feeding. Hens that had been exposed to DDT when fed a high protein ration with partial starvation showed more depletion of DDT in the eggs than a control group. Management practices for depleting stored pesticide in animals are being studied. The occurrence of pesticides in pheasants and big game and other studies of pesticide residues in animals and animal products and ways of avoiding or depleting residues are being studied. (E) Agr. Exp. Stas. in: Ala., Ariz., Calif., Davis, Conn., Storrs, Idaho, Ky., Md., Mich., Miss., N. Mex., N. Y., Ithaca, N. C., Ohio, Ore., S. Dak., Tenn., Tex., Utah, Wis., Wyo.

Field Crops

Fate of CIPC in Soybeans. Use of an herbicide labeled with radioisotopic carbon in different positions has provided convincing evidence for the loss of the isopropyl moiety of CIPC in soybeans. Using ring-labeled and side-chain labeled CIPC, it was shown that the herbicide is degraded in the roots, and that most of the isopropyl alcohol released is translocated to the shoot. Some of the ring structure accumulates in the shoot. Distinct differences were noted in the extent of these reactions with peas, corn, and cucumber. (I) Fargo, N. D.

General aspects of research partially supported by Hatch and McIntire - Stennis funds. The residues of herbicides and other pesticides applied to field crops and pastures under different conditions and to control different pests indicated there were ways of effectively controlling pests with a minimum of residue. First crop of alfalfa forage and soil from plots treated the previous year with chlorinated hydrocarbons showed no residue in the forage but some residues not exceeding 1 ppm were found in the soil. Studies of drift of pesticide dusts showed that inversions of air movement will result in airborne particulate movement upwind and downslope, downwind and downslope and downwind and upslope in winds of 0.25 to 3.0 mph. (E) Agr. Exp. Stas. of: Ala., Md., N. Y., Ithaca, N. C., P. R., S. Dak., Vt.

Horticultural Crops

General aspects of research partially supported by Hatch and McIntire - Stennis funds. Studies of pesticides and pesticide residues in relation to horticultural crops have been continued. Effects of pesticide residues on growth were determined. Significant growth reductions of low bush blueberries were associated with levels of foilliar arsenic of 6.7 ppm or higher. A study of the fate of a chlorinated hydrocarbon insecticide applied to a cranberry bog showed it could be found in a drainage ditch soil, pond soil, aquatic plants, and fresh water mollusks. Beneficial effects of an early summer application of a growth regulator have been obtained on apple fruit. Other relationships of pesticides and horticultural crops were studied. (E) Agr. Exp. Stas. of: Ala., Calif., Davis, Me., Md., Mass., N. Y., Ithaca, Pa., P. R., Wis.

Forests

General aspects of research partially supported by Hatch and McIntire - Stennis funds. Investigations of the relationship between Simazine and phosphorus in one month old red pine seedlings utilizing a modified agar incubation medium and radioactive tracer technique revealed an influence of Simazine on uptake, accumulation and translocation of phosphorus. Low concentrations of Simazine stimulated and higher concentrations decreased uptake and accumulation of phosphorus by roots. All concentrations of Simazine studied resulted in increased translocation of phosphorus from roots to stems and needles. The phosphorus content of stems was not influenced by Simazine. (E) Ind. Agr. Exp. Sta.

TARGET V

TO STUDY ECONOMIC ASPECTS OF PEST CONTROL; SURVEY PESTICIDE USE;
 DETERMINE THE SUPPLY AND REQUIREMENTS FOR PESTICIDES; AND
 GIVE ASSISTANCE TO CONTROL AGENCIES AND INDUSTRY IN
 EMERGENCIES

Aggregate Economic Implications of Pest Control in Agricultural Production.

The aggregate economic implications of factors related to pesticide use and the economic impact associated with banning specified chemicals will be important parts of the investigations during fiscal year 1967. A co-operative research project has been initiated with the Agricultural Experiment Station in Missouri to conduct an economic analysis of the productivity of chemical pesticides and other selected resources in agriculture. The factors related to production being investigated in this study are land, labor, and the important capital inputs of pesticides, machinery, fertilizer, and buildings. (I) Washington, D. C., and (E) Mo. Agr. Exp. Sta.

Legal Implications of Federal Water Pollution Control Act. A small study was initiated to assess the legal implications of the Federal Water Pollution Control Act of agricultural operations. (I) Fort Collins, Colorado.

Analysis of Farm Costs and Returns for Alternative Pest Control Methods. Two studies, in cooperation with the Agricultural Experiment Station in Nebraska and Michigan, are currently underway that relate to economics of pest control methods. Preliminary results are not expected from these studies until early 1967. (I) and (E) Lincoln, Nebraska; East Lansing, Mich.

Marketing Pesticides. Pesticide dealers, farm supply stores, feed and seed dealers, nursery, lawn, garden center, etc., were interviewed as to classes of pesticides sold, size and complexity of business, personal characteristics, knowledge of pesticides, attitudes, etc. In one survey the dealers, in general, did not seem to favor including pesticides in their business. They viewed sale of pesticides as a necessary evil. Almost half the dealers interviewed did not plan to increase their pesticide

business. There was poor knowledge about pesticide materials. Dealers having a larger volume of pesticide business were more likely to know answers than small dealers. Farmers were also surveyed for sources of information, rates of adoption and purchasing pattern. (E) Ala., Alaska, Ga., N. Mex., and Tenn. Agri. Exp. Stas.

Pesticide Production and Sales. Total production and sales of synthetic organic pesticides surged ahead at a greater rate a year ago than for several years. Producers' sales rose 84 percent in weight and 225 percent in dollar value from 1955 to 1965. The sale of chemicals such as carbon disulfide, carbon tetrachloride, ethylene dibromide, paradichlorobenzene and sulfur, used only in part for pest control, would augment the 1965 production figure of 875 million pounds of pesticide chemicals to around 1,150 million pounds going into domestic and export trade.

The growth of herbicide production and sales is the most outstanding feature of the pesticide picture. Producers' sales of synthetic organic herbicides in 1965 amounted to \$211 million, up 29 percent from 1964. Synthetic organic herbicides are generally more expensive than either fungicides or insecticides; the average unit value of sales by the producers was \$1.146 per pound in 1965, 20 cents higher than two years before. The average unit value of fungicides was 46 cents and of insecticides 50 cents in 1965. (I) Washington, D. C.

Imports. No statistics are available showing total U. S. pesticide imports. Synthetic benzenoid pesticides and botanical products make up most of such imports. The value of U. S. imports of benzenoid (cyclic) type of organic pesticides in 1965 was \$3,008,000, 42 percent above 1964. The United Kingdom, Denmark and West Germany shipped 88 percent of the 1965 tonnage, including large quantities of dichlone, diquat, MCPP and methyl parathion. Imports of the major botanical products pyrethrum, rotenone and nicotine in 1965 had a value of \$6,515,000. (I) Washington, D. C.

Exports. Data thus far available for calendar 1966 show the value of pesticide exports to have risen 38 percent over the corresponding period in 1965, from nearly \$136 million compared to only \$98 million a year ago. Total value of exports in 1965 was \$133 million. The materials are of tremendous value in food production and health protection abroad.

Canada, Mexico, Egypt and Brazil in 1965 led in that order as recipients of U. S. exports of pesticides. Egypt and Brazil rose to the third and fourth places held by Japan and Colombia in 1964. Sizeable quantities of pesticides have gone to the Soviet Union in recent years. Exports to Yugoslavia have been sizeable each year, with smaller amounts lately going to Czechoslovakia, Hungary, Poland, and Bulgaria. (I) Washington, D. C.

Carbaryl. This is the major carbamate insecticide on the U. S. market. Being low in toxicity to fish and warm-blooded animals and breaking down quickly to leave no residue, it is utilized in a number of Federal and

State spray programs and in much private insect control. Nearly 95,000 acres of Northeastern forests were treated in 1966 with this insecticide under the Federal State program for gypsy moth control. Carbaryl is employed in the State-financed campaign to eradicate the pink bollworm in California. Several other carbamate insecticides have been cleared recently for limited use. (I) Washington, D. C.

Pyrethrum. This insecticide has been in tightening supply owing to unfavorable weather and labor conditions in eastern Africa. Kenya, Tanganyika (now with Zanzibar known as Tanzania) and Ecuador are the three leading producers in that order. Kenya produced 5,000 tons of dried flowers during the 1964-65 season, down 13 percent from the previous July-June crop year. The Tanzania crop amounted to over 2,600 tons, up 20 to 25 percent over the previous season. Ecuador produced 2,000 tons and is expanding its acreage to become soon the second largest producing country. Total world production of flowers last year was 9,800 tons or more. (I) Washington, D. C.

Liquid Carriers of Pesticides. Large quantities of light petroleum fractions and xylene types are used as solvent carriers of pesticides. Suitable emulsifiers are added to the solutions, thus forming emulsifiable concentrates ready for dilution with water. Kerosene and heavier aromatics are used in large quantities but xylenes are increasing for this purpose as they are adapted to formulating liquids containing multiple (2, 3 or even 4) toxicants. The xylenes are less toxic to plants, they are purer and they are better solvents than heavy aromatic types.

Consumption of liquid formulation is growing, replacing much of the use of dusts (except perhaps where these are in the form of wettable powders). One reason is that liquid sprays do not drift as much as dusts. The total volume of xylenes, heavier aromatics and kerosenes used in 1965 is estimated at 50 million gallons of which nearly half was xylene. It should increase to 55 million gallons by 1967. (I) Washington, D. C.

Granular Formulations. The market for pesticides in granular form is growing rapidly. These preparations owe their popularity to their ability to fall through trees and other vegetation when applied from the air, for placement on or near the ground to have maximum effectiveness against weeds, soil insects, etc. Their use avoids undesirable residue on vegetation in the treated area, drift to susceptible crops, and loss of toxicant by drift. Vermiculite and the clay attapulgite are the carriers used most in granule production. Particle size must be kept within certain limits. The active chemical is coated on the surface of the granule, along with urea when acidity of the clay must be neutralized to avoid breakdown of the pesticide. The demand for clay carrier suitably sized for this purpose in 1964 amounted to 70 million pounds and jumped to an estimated 130 million in 1965, enough to make 150 million pounds of finished preparations. The 1966 market is expected to require 200 million pounds or more of this type of carrier. (I) Washington, D. C.

TARGET VI
TO CONTROL PESTS

Cooperative Economic Insect Survey. More than 1,200 cooperators furnished insect condition reports for publication in the weekly Cooperative Economic Insect Report during the year. This report was mailed to approximately 3,500 addresses. Cooperative agreements provided for survey programs in 29 States. Observations and evaluations of insect pest activity assist farmers to more adequately protect their crops before widespread damage occurs. (I and E) Nationwide.

Survey and Detection Training. Workshops were conducted in various States to train personnel in detection of insect pests which may invade the country. Special attention was given to detection of introduced pests such as alfalfa weevil, face fly, and cereal leaf beetle in new areas of their ecological range. A total of 229 participants attended these cooperative sessions. (I and E) Ala., Mont., Va., N. C., S. C., Kan., Nebr.

Oak wilt control. Cooperative oak wilt control programs were conducted in Pennsylvania, Virginia and West Virginia, and aerial surveys to determine the trend of this fungus disease were made in Arkansas and Kentucky. A total of 32 million acres were surveyed and 3,928 infected oaks were destroyed to eliminate sources of inoculum. (E) States of Ark., and W. Va. cooperating with Upper Darby, Pa., and Atlanta, Ga.

Soybean Cyst Nematode Survey. Since its discovery in the U. S. in 1954, soybean cyst nematode has grown in economic status each year because of the increasing importance of the soybean industry. The program is designed to prevent spread until effective controls are developed. No satisfactory chemical treatment is available. Surveys were made in principal soybean areas to locate new infestations. About 760,000 acres were surveyed and the nematode was found for the first time in 24 counties in 6 States. (I and E) Southern and Central States.

Forest Pest Detection Program. Forest pest detection surveys were expanded on forest lands of all ownerships. Early detection is a key requisite to prevention and prompt suppression of outbreaks and the avoidance of large-scale control programs. The Forest Service cooperates with 23 States in a cost-sharing program for the recurring phases of pest surveys and control on non-Federal lands. These States and the National Forests provide surveillance for pest occurrences on 66 percent of the commercial forest land in the Nation. (E) States of Calif., Fla., Ga., Ind., Maine, Mich., Minn., Miss., Mo., N. H., N. J., N. Y., N. C., Ohio, Ore., Pa., Tenn., Tex., Vt., Va., Wash., W. Va., and Wis.

Ash dieback detection. Dieback is a serious malady of ash in several of the eastern and midwestern States. Detection and classification of ash dieback on large-scale aerial photographs indicate that the disease may be present in more than the six states immediately surrounding New York. Typical symptoms of dieback were detected on the color photographs in Ohio, Michigan, Indiana, and Illinois, indicating this aerial interpretation method may find immediate application in all of the North Central and Northeastern States. (I) Berkeley, Calif. and Upper Darby, Pa.

Bark beetle detection. Aerial color photography was used successfully to detect trees newly attacked by bark beetles in the Black Hills of South Dakota. Twenty percent of the dying trees was detected in May and 72 percent in July, following beetle attack the previous year. The earlier detection of beetle-infested trees is of material aid in planning and executing control of the Black Hills beetle. (I) Berkeley, Calif., and Denver, Colo.

European pine shoot moth. In 1966 a total of 78 communities outside the European pine shoot moth containment zone were surveyed in the State of Washington. The moth was found in Longview, Prosser, and Port Angeles. In Oregon, 67 communities outside the Portland metropolitan area were surveyed with negative results. One nursery in northeast Portland was found infested but all pines in the nursery were fumigated before moth flight. (E) States of Ore., and Wash.

Scleroderris pine canker. Twenty ranger districts on four Lake States National Forests with two-to ten-year-old red and jack pine plantations were surveyed for Scleroderris lagerbergii, a fungus disease. The survey showed that the disease was present and causing severe damage on all 20 ranger districts where red or jack pine had been planted since 1955. Mortality averaged 40 percent in the red pine plantations and 36 percent in the jack pine plantations. The surveys will be broadened in an attempt to determine the range and incidence of this disease which has a long history of injuries to young plantations and nurseries in Europe. (I) Upper Darby, Pa.

Spruce budworm project cancelled. Close surveillance and evaluation of a spruce budworm epidemic on the Salmon National Forest, Idaho, led to cancellation of a planned 100,000-acre aerial spray project when it was

found that natural factors had caused a material decrease in budworm populations. (I) Ogden, Utah.

White pine blister rust. Over two million acres in the valuable five-needled pine-producing areas of the Nation were systematically sampled to determine the status of the blister rust disease, control needs, and the best control methods for protection of each stand. (E) States of Calif., Conn., Idaho, Me., Md., Mass., Mich., Minn., Mont., N. H., N. Y., N. C., Ore., Pa., Vt., Va., Wash., W. Va., and Wis.

Boll Weevil. Multiple applications of low volume malathion at 12 - 16 oz/acre have replaced the chlorinated hydrocarbon treatments used in former years. This effective application procedure has essentially eliminated all adverse effects on nontarget organisms. (I and E) Texas.

Pink Bollworm. Pink bollworm is a major pest of cotton in any country where it occurs. In this country, damage and spread of the insect has been held down through quarantine enforcement and the practice of recommended cultural control measures by the farmer. These actions have kept pink bollworm out of cotton areas east of the Mississippi River. Some recent expansion in the West has occurred, however. Infestations were found for the first time in southern California and adjacent areas of Mexico in late 1965. A program has been initiated to suppress these outlying infestations to prevent further spread of the pest in California and western Mexico. (I and E) Southern and Southwestern States, Mexico.

European chafer. All of the principal grassland areas of the United States fall within the ecological range of European chafer. Since its discovery in New York in 1941, this root feeder has been contained in areas of New York, New Jersey, Pennsylvania, Ohio, and Connecticut. Soil treatments were applied to 11,228 acres during fiscal year 1966 to control the pest. (I and E) N. Y., N. J., Pa., Ohio, Conn.

Gypsy Moth Containment. Containment of gypsy moth in the Northeast has protected 100 million acres of susceptible forests in 25 States in the eastern half of the Nation. During the year, chemical controls were applied to outlying infestations in New Jersey, New York, and Pennsylvania. More than 95,000 acres were treated in the three States. In addition, 14,866 acres were treated mechanically by saturation with sex-lure traps. (I and E) Northeastern States.

Japanese Beetle Eradication. An isolated infestation of Japanese beetle at Sacramento, California, was declared eradicated in the fall of 1965. This pest which attacks roots, foliage, and fruits of many plants has been known in the East since 1917. Its spread west of the Mississippi River has been prevented through an effective containment program. During the year, 43,000 traps were used to detect possible spread of the pest to noninfested areas. Treatments were applied to 28,467 acres to control incipient infestations. (I and E).

Sweetpotato Weevil Containment. The containment program against sweetpotato weevil in seven southern states protects a large segment of the sweetpotato industry from infestation. During the year, 2,486 acres and 2,236,974 bushels of sweetpotatoes were treated to control the weevil. In addition, cultural controls were carried out on 20,912 acres. (I and E) Ala., Ga., La., Miss., N. C., S. C., Tex.

Scabies eradication program. Lime-sulfur, Nicotine Sulfate, Toxaphene, and Lindane are used as permitted dips in cattle and sheep scabies eradication programs and have been the major tools in the reduction of these diseases to their present low incidence. (I) Nationwide.

Screwworm Control. Coumaphos at a 0.25% concentration is used as a larvacide to spray cattle affected by outbreaks of screwworms. This spray is part of the hot spot treatment for those sporadic outbreaks of screwworms which result from migration of screwworm flies from Mexico. Animals infested or exposed to screwworms are protected by the residual coumaphos from screwworm infestation for about 10 days. Extremely young and lactating animals are not treated with the larvacide. Principal benefit of this treatment is denial of susceptible host animals to the screwworm fly. (I) Southwest.

Dermacentor Nitens Tick Control. Toxaphene spray and Lindane as a control application into the ears has been instrumental in Florida in the reduction of Dermacentor Nitens tick population in horses and, therefore, a valuable tool in the control of Equine Piroplasmosis. (I) Nationwide.

Imported Fire Ant. Increased control and eradication efforts coupled with the enforcement of quarantine regulations have served to contain the imported fire ant within the general area of previous infestations, which represents an estimated 5 percent of its ecological range. This year treatments for this pest were completed on more than 6 million acres. This acreage, treated primarily by air, represents a new high for a single year and is indicative of the renewed interest and effort directed at eradication by cooperating agencies and the general public. Treatment operations were, for the most part, carried out on the periphery of the generally infested area and in isolated spots removed from other infestations. More than 13 million acres had been treated since the beginning of the program. Mirex continued to be the insecticide of choice. (I and E) Southern States.

Burrowing Nematode - citrus decline disease. The "spreading decline" disease of citrus is caused by the burrowing nematode. The nematode has been found infesting citrus in the country only in Florida. Efforts were continued during the year to contain the infestation by chemical barrier soil treatment around infested groves. In severely infested, nonproductive groves, eradication treatments are being applied. Survey and regulatory activities were strengthened during the year to prevent spread. (I and E) Fla.

Balsam woolly aphid predators. *Aphidecta oblitterata*, a predator of the balsam woolly aphid, was released at several locations in the stands of Fraser fir in the Mt. Mitchell area of North Carolina. It is anticipated that these foreign predators will survive and multiply, and that their progeny can be collected and released in other valuable Fraser fir stands of the Southern Appalachians. (I) Asheville, N. C.

Bark beetle control. Damage to forest stands by bark beetles was widespread and severe in the United States in 1966. Every effort was made to control infestations by logging the infested trees. When infested trees could not be salvaged, they were cut and burned. Wherever feasible, those that were not merchantable and could not be cut and burned were cut and sprayed with toxic oils to destroy the beetle brood. (I) Portland, Ore., San Francisco, Calif., Ogden, Utah; Missoula, Mont., Albuquerque, N. M.; Denver, Colo., and Atlanta, Ga.

Dwarfmistletoe control. Control of dwarfmistletoe was achieved on National Forest lands in seven western States when a total of 80,650 infected trees were cut or pruned on 29,870 acres to eliminate sources of infection. To assure a future stand of trees free from dwarfmistletoe, all infected living pines were cut on burned-over areas on the Bitterroot National Forest, Montana, and on the Apache National Forest, Arizona. Plans were made to initiate a study of silvicultural control of dwarfmistletoe in ponderosa pine stands on the Ochoco National Forest in Oregon. (I) Missoula, Mont., Albuquerque, N. M., and Portland, Ore.

White pine blister rust - cultural control. A total of 570,389 white pine trees were pruned or excised to save them from the ravages of blister rust, in Michigan, Minnesota, New York, Oregon, and Wisconsin. (E) Mich., Minn., N. Y., and Wis., (I) Upper Darby, Pa., and Portland, Ore.

Measures Taken Outside Continental U. S. To Prevent Entry of Plant Pests. Additional and significant parts of the plant quarantine program carried on outside the country contributed to a reduced use of pesticides and treatments within the continental U. S. Significant are the fruit fumigations supervised by the Department in Mexico and Hawaii, the fruit refrigeration treatments abroad ships carrying agricultural products to this country, and bulb inspections now being performed in various European countries and the Republic of South Africa. (I) Hyattsville, Maryland.

Citrus Blackfly Eradication. Citrus blackfly is not known to occur in the United States. Isolated infestations were eradicated in Key West, Florida, in 1934 and southern Texas in 1956. To keep this dangerous pest out of U. S. citrus, a preventive program is carried out with the Republic of Mexico when the pest occurs in wide areas. An eradication zone is established in northern Mexico, while the remainder of the country is under a biological control program. In the spring of 1966, incipient infestations discovered in Matamoros, Mexico, were eradicated. Over 1,000,000 host plants were inspected during the year with 44,000 receiving treatment. (E and I) Mexico, Ariz., Tex.

Domestic Plant Quarantines. Efforts were continued to provide the public information concerning the objectives of quarantine action and to encourage cooperation. Special reports were released covering the function and purpose of domestic plant quarantines. All certificates and permits were modified to provide for the use of Federal certificates in areas included only under regulation by parallel State quarantines. At the request of the Plant Boards, a model pest control law was prepared and reviewed with State regulatory officials. The law was then redrafted and submitted to the States for their guidance. Some amendments have been made in State laws utilizing this guideline. (I) Hyattsville, Md.

Cattle Fever Ticks. Arsenic and Delnav dips are used to eradicate cattle fever ticks when they appear in the Quarantined Buffer Zone along the Texas-Mexico Border. Also ruminants, swine and equine stock are inspected and treated in a Delnav solution to preclude the possibility of introducing exotic ticks to this country. The use of these products has been instrumental in keeping exotic ticks from spreading widely into and within the United States. Many of these ticks act as vectors for serious foreign animal diseases.

Phony Peach and Peach Mosaic. Phony peach and peach mosaic are serious virus diseases of certain stone fruits, particularly peaches. Spread of the diseases to new areas has been prevented through destruction of infested trees and the regulation of the movement of plants and propagating material. Over 4,300 infested plants were treated or destroyed during fiscal year 1966 to control these diseases. (I and E) Southern and Western States.

White-Fringed Beetle. Regulatory and control measures have confined white-fringed beetle, a serious pest of many crops, to less than one percent of the land area in the 11 infested Southeastern States. The success of the program, however, is being affected by the restricted use of persistent soil insecticides. Studies have been undertaken to test alternate insecticides and to attempt to find effective biological control agents. (I and E) Southeastern States.

Barberry Eradication. Stem rust is the most destructive disease of wheat, oats, barley, and rye. The barberry plant is the alternate host necessary for perpetuation of the disease in the eradication area. Elimination of barberry as the source of local rust spread and as a source of hybridization of rust races has contributed to a marked decline in losses from stem rust. During the year about 4,000,000 rust susceptible barberry bushes were destroyed in 16 States in the continuing effort to eliminate barberry from principal grain-producing areas. (E and I) Western, Central, and Eastern States.

Biological control of larch casebearer. Parasites of the larch casebearer were reared in large numbers and 260,000 of them were released at 39 localities in northeastern Washington, northern Idaho, and Montana where casebearer populations and resultant defoliation have been heavy.

Establishment of the parasite in all locations has been demonstrated. Additional parasite liberations at other locations are planned for 1967. (I) Missoula, Mont., and Portland, Ore.

Cereal leaf beetle parasites. Rearing of the cereal leaf beetle and its major introduced parasites has been initiated to prepare for extensive parasite colonization and mass releases. (I) Niles, Michigan.

Cereal Leaf Beetle. Application rates of malathion were reduced from 5 to 4 fluid ounces per acre for the control of cereal leaf beetles. Movement of untreated farm commodities are a hazard of spread of cereal leaf beetle. Promising substitute fumigants are being tested in an effort to preclude undesirable residues in these commodities. (I and E) Mich., Ill., Ind.

Gypsy Moth Population Suppression. Both radiological and chemical sterilization means of population suppression are being pilot tested in an effort to develop suitable field operational procedures. Several species of introduced parasites are being mass reared and liberated throughout the peripheral areas of new infestation. (I) Mass., Vt.

Imported Fire Ant. Methods improvement field tests revealed that two 1-1/4 pound applications of mirex bait per acre were fully as effective against the imported fire ant as the two 2-1/2-pound applications formerly made. The reduced dosage results in savings on this program and achieves control with only one-half of the amount of actual toxicant normally used. (I) Miss., La.

TARGET VII

TO MONITOR THE PRESENCE AND DISTRIBUTION OF PESTICIDES IN PLANTS,
ANIMALS AND THEIR PRODUCTS, AND IN THE ENVIRONMENT

Methods for Pesticides Monitoring. The need for rapid and reliable techniques has resulted in considerable effort being placed on development of methods of analysis that would properly support a pesticides monitoring program of the magnitude now underway in the Department. A manual of "Methods of Analysis for Pesticides in Agricultural Monitoring" has been prepared and will be published in fiscal year 1967. The manual is not intended to be used as a research instrument, but will be valuable for similar laboratories which are dealing with pesticides encountered regularly in environmental samples. (I) Gulfport, Miss.

Forest Insect and Disease Control. Monitoring programs carried out on eleven control projects revealed no serious adverse effects to fish, wildlife, domestic livestock and domestic water supplies. Assisting in the complex monitoring programs were scientists from the Bureau of Sport Fisheries and Wildlife Service; Public Health Service; State fish and wildlife agencies. (E) Mont., Idaho, Ore., N. Mex., Mich., Pa., New Hamp., Wisc., and N. Carolina. (I) Missoula, Mont., Ogden, Utah, Albuquerque, N. Mex., Portland, Ore., Upper Darby, Pa., and Atlanta, Ga.

TARGET VIII

TO ADMINISTER THE REGULATORY STATUTE--THE FEDERAL INSECTICIDE,
FUNGICIDE AND RODENTICIDE ACT--TO ASSURE PROPERLY LABELED
PESTICIDES, WITH GUIDELINES FOR THEIR SAFE AND EFFECTIVE
USE, AND TO PREVENT THE MARKETING OF HARMFUL, ADULTER-
ATED OR MISBRANDED PRODUCTS

Product Surveillance-Seizures. Unregistered, adulterated, or misbranded products may be seized in the interest of public protection. In 1966, 106 products were seized. Examples of the types of violations found are (1) an insecticide for use on grain adulterated with a chemical not named on label; (2) a disinfectant which did not, when tested, meet label claims for effectiveness; (3) aerosol bombs which contained less active ingredient than declared; (4) a herbicide which failed to bear adequate directions for use. (I) Washington, D. C.

Cancellation of Registration for Certain Uses. In fiscal year 1966, 475 products containing the chemicals aldrin and dieldrin were cancelled. These products bore directions for use which could result in illegal residues on certain crops and in some cases, in milk from cows fed the crops. The uses of aldrin involved 25 crops and dieldrin 23 crops.

The use of products containing thallium by private individuals in and around the home was determined to be unsafe. Registration was cancelled for 58 products bearing such directions. (I) Washington, D. C.

Dissemination of Information on Registered Uses. Pesticides Regulation Division issues the "USDA Summary of Registered Agricultural Uses" which is a compilation of abstracts of registered pesticide use patterns involving food and feed. This Summary is made available to and is widely used by registrants, Federal and State extension and research agencies, and food processors. It serves as a guide in the preparation of labeling and recommendations for the use of pesticides. More than 600 use patterns for over 400 chemicals are listed. Notices of additions and changes are issued monthly. In 1966 about 300 such notices were issued. (I) Washington, D. C.

Dissemination of Information to State Regulatory Officials. To insure uniformity of registration policies between the various states and the Federal Government, the PRD furnished information on the registration of new chemicals to all state officials responsible for administering pesticide laws. During 1966, this type of information on 24 newly acceptable chemicals was compiled and distributed to state officials. (I) Washington, D. C.

Interdepartmental Agreement on Registration. In accordance with this agreement, applications for registration are referred to the Departments of Health, Education, and Welfare and of the Interior. Concurrence has been reached between the Departments on labeling requirements for certain patterns of use. These have been made a part of the registration requirements by the U. S. Department of Agriculture. A total of 12,772 labels were referred by Agriculture to the other Departments for their review and opinion. (I) Washington, D. C.

TARGET IX -A

TO EDUCATE AND INFORM THE PUBLIC ABOUT THE IMPORTANCE OF PESTICIDES AND PEST CONTROL AND THE NEED FOR SAFE AND PROPER USE OF PESTICIDES; MAINTAIN A PESTICIDES INFORMATION CENTER; COORDINATE AND REVIEW PESTICIDE AND PESTICIDE-RELATED ACTIVITIES OF THE U.S. DEPARTMENT OF AGRICULTURE AND COORDINATE THEM WITH OTHER FEDERAL, STATE, AND PRIVATE ORGANIZATIONS

Television and Radio. Developments in pest control research and regulatory activities were highlighted in weekly and monthly radio and television reports distributed by the Department's broadcasting services. Also numerous news items and interviews were broadcast over local stations in connection with field pest control research and control activities to inform the public about the nature of such activities and precautions taken to assure maximum safety for people and wildlife. (I) Washington, D. C.

Movies and Television Spots. The Department cooperated with Maryland, New York, and Kansas Extension Services in producing a series of visuals which includes: "People and Pests," a 13½-minute, 16-mm. color sound movie; and "Safe Storage of Pesticides," a 4½-minute, 16-mm. color sound movie (N.Y.); and a series of 20-60-second television spot announcements on pesticides. The series developed in Maryland features "Larry The Label," whereas the 13 spots developed in Kansas includes use of cartoons and/or people to extoll their messages on safe and proper use, handling, and storage. The half "Larry The Label" series is currently in use in 50 States; whereas, the first half of the Kansas series has just been completed. Copies of all visuals are made available to States interested through a cost-purchase arrangement. (I and E) Washington, D. C. and States indicated.

Advertising Council Endorsement. For the third successive year, the Advertising Council notified broadcasters across the Nation that it had renewed its endorsement of the USDA pesticides safety program for 1966. This program was designed for the general public with its message directed at housewife and gardener as well as farmer. The Council's valuable support resulted in the extensive public service use of filmed and recorded materials supplied by the Department to national networks and individual stations. Materials made available included numerous spot announcements and special news and feature stories. (I) Washington, D.C.

Portable Exhibit. The Department cooperated with the North Carolina Extension Service in the developing of a portable pesticides exhibit for use at meetings, fairs, and short courses concerned with the use of pesticides. Blueprints and instructions for making up this versatile exhibit, etc. are available upon request from North Carolina. Subject matter for the exhibit can be varied readily since pegboard was used for panel construction. A number of other States also developed some excellent exhibits on pesticide-chemicals from their own funds. The North Carolina exhibit can be purchased or readily constructed from the plans available. (I and E) Washington, D. C. and North Carolina.

Distribution of Informational Materials. Providing the public with the latest information on safe and effective pest control measures is a continuing job of the Department. In carrying out this function in 1966, the Office of the Coordinator, Agricultural Chemicals Program, distributed over 150,000 pieces of literature relating to pesticide use, laws, regulations, registered uses, residue tolerances, and safety precautions concerned with the proper handling, storage and use of pesticides. This figure did not include bulk shipments and items that the originating sources mailed directly to the chemical leader/coordinator in each State. (I and E) Washington, D. C. and State Extension Services.

News releases. Release of information to news media on the Department's pesticide and pest-control activities continued at an expanded rate. More than 40 press releases relating specifically to pesticides were issued, along with an additional 50 news releases on pest research and regulatory activities and 5 picture stories on Department pest-control programs. (I) Washington, D. C.

Newsletters. All States have been encouraged to develop and use newsletters for transmitting pesticide information to their various clientele groups. Today, almost without exception, we find that the State Extension specialists and county agents rely on this rapid means of communicating essential information on pesticide uses, etc. (I and E) Washington, D. C. and State Extension Services.

Publications. A number of excellent pesticides publications were developed for Extension use in 1966. These publications were designed to provide users with factual information that would help them make sound decisions based on their individual cropping systems. One of the outstanding State publications on pesticides is Cornell University's Miscellaneous Bul. 74, entitled "A Guide To Safe Pest Control Around The Home." This publication was developed under the leadership of the Extension Program Leader, Chemicals-Pesticides, Cornell University. Pennsylvania also developed an excellent series of 4-H Club publications on pesticides which were made available to States on a cost purchase arrangement. To date, twenty States have purchased 81,000 copies of the 4-H Club literature. (I and E) Washington, D. C. and State Extension Services.

Magazine articles. In the first 9 months of 1966, the Agricultural Research magazine published 30 articles on pest control, including reports on new methods of pesticide application, safer methods under development, pest-resistant crop varieties, and monitoring of pesticide residues. More than a fourth of the major articles in the magazine have been related to pest control. (I) Washington, D. C.

Speeches. USDA policy on pesticides regulation and pest control was explained in speeches by Department officials before such influential organizations as the American Chemical Society, National Association of Soil and Water Conservation Districts, American Society of Agronomy, and Weed Society of America. (I) Washington, D. C.

Liaison. The Department has maintained almost daily liaison and cooperation with numerous agencies, organizations and groups such as the National Agricultural Chemicals Association, National Safety Council, National Cotton Council, National Cannery Association, Manufacturing Chemists Association, National Wildlife Federation and the National Pest Control Association in planning and counseling with them on programs concerned with pesticide use. Another phase of the expanded liaison effort has been the role the Department has played in gathering information and calling appropriate groups' attention to problem situations and incidents/accidents involving pesticides which occurred in the field. (I and E) Washington, D. C. and State Extension Services.

National Safety Council Program. The Council's 1966 farm chemicals safety program was planned and implemented in cooperation with the Department. Extension Service personnel helped establish local chemical safety groups, and USDA informational materials were distributed in quantity to these groups. Department pest control programs and materials were described in the winter issue of "Safer Farm Families," published by the Council. (I and E) Washington, D. C., National Safety Council.

Pesticide Safety. The Department's pest Control phrase, "PROTECT ... Use Pesticides Safely, Follow the Label," gained increasing acceptance across the nation. The symbol appeared on all USDA publications relating to pest control. It has been promoted through a television spot announcement, a new pest control exhibit, and continuing distribution of brochures and zip-a-tone reproductions. (I) Washington, D. C.

Activated Charcoal, 1953-64, A selected list of references. A special bibliography was compiled and issued in May 1966. (I) Washington, D. C.

Toxicity of Herbicides to Fish and Wildlife. Compilation of a special bibliography was begun. (I) Washington, D. C.

Pesticide Use Records. FES has emphasized the importance of all pesticide users keeping complete records in their work with the State Extension Services, commodity organizations and industry groups. Items suggested for inclusion in record books, charts, etc. were: date, time and rate of

application, method of application, name of pesticide and company whose product was applied, weather conditions, and other pertinent remarks. This added emphasis resulted in development of pesticide record use sheets in a number of States. North Dakota included a separate section in their record book as a means of encouraging farmers to record pesticide use data. The North Dakota record book was designed for use over a 5-8 year period since pesticide use patterns are so important in crop rotations, etc. (I and E) Washington, D. C. and State Extension Services.

Accident and incident documentation and analysis. In cooperation with State Departments of Agriculture the USDA investigates and documents pesticide accident and incidents on a nationwide basis for the Department. The objectives of the program are to provide the Department with factual information about the cause and impact of pesticide accidents, and to release the facts uncovered through these activities so that they can be translated into vigorous educational programs directed toward the user, to avoid harm to himself and to avoid illegal residues in food and feed through misuse or accidental exposure. (I and E) Hyattsville, Md. State Departments of Agriculture.



Use Pesticides Safely
FOLLOW THE LABEL

U.S. DEPARTMENT OF AGRICULTURE